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ART. XXX.—*On the Musical Ratios, and our Pleasure in Harmonious Sounds;* by HENRY WARD POOLE.

UTILITY, in a liberal sense, may be assumed to be the goal of scientific investigations. We should all rejoice if the discoveries in heat should lead to material results in making available those immense forces which are said to result from the burning of a pound of hydrogen or of coal. It would be gratifying if the laws of light shall be so far understood, that we can have photographs fixed with the colors shown in nature. In the department of sound, utility seems to be almost entirely confined to the musical department, where complicated vibrations and relations are excluded, and only the simple and regular are admitted. And here, strange to say, in all times, the practice has been in advance of the science.

Singers and players have used, and still are using, intervals which please themselves and their auditors, while the scientists have not known that they used them, and have declared that really harmonious sounds are discordant and harsh.

To illustrate this assertion, I take the last and most complete work on Sound* that I have seen. The excellence of other parts of this work, and the high merits of the author, make it noteworthy that after such minute experiment with metal and wooden rods, disks, singing flames, etc., the higher department should have received so little attention.

* Sound. A course of eight lectures delivered at the Royal Institution of Great Britain, by John Tyndall, LL.D., F.R.S. London. 1867.

But although every singer and musician may have his inner revelation of what musical intervals really are, it is important that they should be understood and acknowledged by the scientific, and the teachers of music.

It is not difficult to find a pair of children, or a quartette of friends, who will sing in perfect tune. But in nearly every church and music room is set up an organ with but twelve pipes in each octave, which can not make a perfect chord, or one which would be tolerated by the vocalists referred to. What is the fault of these instruments? Can instruments be made and played in perfect tune? First of all, what are the notes, the scales, the harmonies, which composers write and artists execute? These are some of the questions whose resolution leads to useful results. The ignorance of teachers leads to the mischief, that they spoil good singers, by compelling them to take intervals from imperfect instruments. An example will show what I mean. Nothing is more common than to sing a seventh, ratio 4 : 7, on the dominant harmony, concordant, and as any one would wish to give it. The theoretical books would have this given as 9 : 16, or about a seventh of a tone too high. A teacher by the rude instruments now in use, would require the pupil to sing the interval with something like this error. The effect on a good singer is to deaden his sensibility and consequently spoil him. It is remarkable that this interval of 4 : 7 is not recognized by Professor Tyndall, who has, apparently, aimed at giving what is known up to the present time. That such an interval is used and is harmonious has been published in this Journal, eighteen years since, and elsewhere.

Euler gives a good theory, which Professor Tyndall quotes as follows.

> Euler analyses the cause of *pleasure*. We take delight in *order*. It is pleasant for us to observe 'means co-operant to an end.' But then the effort to discern order must not be so great as to weary us. The simpler the terms in which the order expresses itself, the greater is our delight. Hence the superiority of the simpler ratios in music over the more complex ones. Consonance, then, according to Euler, was the spiritual pleasure derived from the perception of order without weariness of mind.

I approve of Euler's explanation but not of Professor Tyndall's statement. I understand that the musical ratios collectively are the simplest of the mathematical ratios, and that these are *equally and entirely perfect and agreeable when duly used in music.*

But our author states that the unison, 1 : 1, is the most perfect. Next comes the octave, 1 : 2, still very harmonious.

Next, the fifth, 2 : 3, is "very pleasing, but the consonance is hardly so perfect as in the last instance; there is a barely perceptible roughness here. Next to the octave, this is the most pleasing combination." The "roughness of the fourth, 3 : 4, is a little more pronounced." The harmony of the major third 4 : 5, is declared "less perfect," and that of the minor third, 5 : 6, "usually [?] less perfect still." And he declares the law that "*the combination of two notes is the more pleasing to the ear, the smaller the two numbers which express their vibrations.*"

No ratio higher than 5 : 6 is mentioned, except 13 : 14, which is declared "altogether discordant." As a reason, it might be stated that the prime 13 is far beyond the limit of musical ratios. The ratios 6 : 7, 5 : 7, 7 : 9, and all reference to the chords derived from seven, are omitted by Professor Tyndall in this course of lectures. But he says that musicians have chosen the simple intervals "empirically, and in consequence of the pleasure they gave, long before any thing was known regarding their numerical simplicity."

If musicians have chosen the most simple intervals as most pleasing, it is not true that they have considered fifths as inferior to octaves, or the latter as less pleasing than unisons. All the intervals named, and those of the harmony of the seventh with their inversions and derivatives, within due limits and properly combined, are entirely perfect and equally pleasing, one with the other. Beyond these limits, all are incomprehensible and alike unharmonious. Theorists have improperly classed fifths as "perfect concords," thirds, as "imperfect concords," and worst of all, the beautiful concord of the seventh, 4 : 5 : 6 : 7, is called a "discord." It is difficult to say why such distinctions were made, unless they came from the imperfect tuning of the keyed instruments which these theorists used.

It appears that Professor Tyndall treats the coincidences of harmony and those of discordant vibrations under the same term; viz., "beats." And, following Helmholtz, he says that beats of 33 per second, are in their "condition of most intolerable dissonance;" and that "with higher rates than 33 the roughness lessens until at 132 it totally disappears." He then examines the several chords, as follows, beginning with the octave:—

Here our rates of vibration, are

512—256; difference=256.

It is plain that in this case we can have no beats, the difference being too high to admit of them.

Let us now take the *fifth*. Here the ratios of vibration, are

384—256; difference=128.

This difference is barely under the number 132, at which the beats vanish; consequently the roughness must be very slight indeed.

Taking the *fourth*, the numbers are

384—312; difference=72.

Here we are clearly within the limit where the beats vanish, the consequent roughness being quite sensible.

Taking the *major third*, the numbers are

320—256; difference=64.

Here we are still further within the limit, and, accordingly, the roughness is more perceptible.

Thus we see that the deportment of our tuning forks is entirely in accordance with the explanation which assigns the dissonances to beats. pp. 299–300.

There is an evident error in the numbers assigned to the fourth. As four tuning forks are mentioned, they are probably those of the key-note, its octave, fifth, and major thirds. The interval of the fourth, then, would be obtained by sounding the fifth with the octave; giving

512—384; difference =128

which would give to the fourth the same "roughness" as to the fifth.

If coincidences in the vibrations of simple chords be what is meant by "beats," it would be easy to show that 33 such beats per second are not necessarily disagreeable. It is stated that 33 vibrations give a "perfect musical tone." If we sound with this its *octave* with 66 vibrations, we shall have a still more agreeable musical effect, as always results from such addition to a very low note—and there will result just 33 coincidences, or so called beats. But if we should add a fifth, with 49·5 vibrations, the effect would not be so good. A major third, with 41·25 vibrations would be intolerable, yet the "beats" would be just 33 in each case. Why is this difference? The answer is found by examining the harmonic series:

1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 : 10.

It is found that the several prime chords, fifth, third, etc., are most sonorous and agreeable when taken in the relative position as above. Assuming that the lowest sound has 33 vibrations per second, its octave follows with 66, the fifth to the last 99, the major third, to the double octave, with five times 33, or 165, and the seventh with seven times 33 or 231. The rule being as follows:

The vibrations of the lowest notes which it is permissible to use in the relations of fifth, major third, or seventh, are in the relations respectively, as the numbers 3, 5, 7. The lowest audible sound may be the limit for sustained or final chords, and

if so, the fifth must have at least three times its number of vibrations, the third five times, and the seventh seven times. At all events these different chords will always keep these relative positions, or a fifth can always be sounded lower than a third, and both lower than a seventh; which accords with the practice of musicians. For certain melodic movements, it would seem as if all these intervals can be taken about an octave lower than the limiting note of 33 vibrations would permit. Can not the vibrations of the octave below, or 16½, be *felt* in union with the octave and other harmonics above, and in this way be considered as audible? For the musical ear hears only what is plain enough to be understood, and relations too remote are often made clear and agreeable by the addition of other sounds. So a note in combination may be audible, which alone is not so.

Composers know the variety and advantages which result from taking chords in their various inversions, positions and distributions; but it is certain that the harmonic series shows the best order and the proportion of each element admissible. Thus, before the seventh is sounded, we have the fundamental note in three octaves, the fifth in two, and the major third only in one.

Professor Tyndall says much about the harmonics, which he calls "overtones." He says:

> And be it remarked, that the overtones are indispensable to the character of musical sounds. Pure sounds, without overtones, would be like pure water, flat and dull.

I believe that pure water is good, either to use in its purity, or to mingle with other elements at pleasure, and that pure sounds are most desirable in singers and in instruments. It was a triumph when the piano-forte was made to give less of the jangling harmonics, and more of the pure fundamental tone of the string. He says that in the organ, the overtones are so much felt to be a necessity, that they are introduced by small pipes, that "in fact, a good musical clang requires the presence of several of the first overtones."

It is asserted by Professor Tyndall that the vowel sounds are due to accompanying harmonics, and that the quality of sounds is also owing to their distinctive harmonics. That a flute sounds differently from a violin is owing to the fact that every flute has certain harmonics, while a violin has others. But one violin sounds different from another, and the material of a tube alters its quality of tone. Each instrument has the characteristic quality of its class, and besides, something distinctive of itself. There does not appear enough evidence to show that

this varied *quality* of tone is owing to such simple cause as what is understood by harmonic tones. If this were true, the perception of the distinctive qualities would be easy, and in the department of a musical ear. But quality of tone in general, is not especially noticed by the musician, who only deals with certain simple and regular forms of vibration. The unmusical ear recognizes as quickly the tone of a voice, or that ring which tells that a dollar is made of silver. One can imagine that the infinite variety in the quality of tones is owing to some difference in the conditions and forms of their vibrations, which the ear distinguishes by some wonderful faculty which is not the higher perception of music. Such power of distinguishing by the different senses is possessed even by the lower animals; in some cases beyond the power of man.

Quality of sound is so little understood at present that distinctive terms are wanting. We speak indeed, of a loud sound, which is one that can be heard at a long distance; of a pure sound, called also smooth, sweet, and even soft, although the tone may be powerful. Any term expressing agreeable qualities to any of the the senses is applied to pleasant sounds. For example we have a *brilliant* tone, borrowing the word from the sense of sight, a *harsh* or *rough* sound, as if to the sense of touch. When, in the theatre, music is desired, very pure in quality and in tune, and soft and even in power, it is technically known as "aerial music." We shall be glad to have more definite knowledge concerning the qualities of tone, but it depends on something outside of the harmonic sounds.

In extension of the theory that beats of 33 per second are the most offensive possible, and that those of 132 are harmless, Professor Tyndall gives the several chords from the octave to the minor third, accompanying each note by its harmonic to the tenth degree. The octave is as follows:

		1 :	2
Fundamental Tone,		264	528
Overtones,	1	528	1056
	2	792	1584
	3	1056	2112
	4	1320	2640
	5	1584	3168
	6	1848	3696
	7	2112	4224
	8	2376	4752
	9	2640	5280

Comparing these tones together in couplets it is impossible to get out of the series a pair whose difference is less than 264. Hence as the beats cease to be heard when they reach 132, dissonance

must be entirely absent from the combination which we have just examined. The octave therefore is an absolutely perfect consonance.

There is something strange in calling a combination harmonious because the rapidity of the discordant beats is so great that they are inaudible. The fact is, that a chord is nearly in tune and begins to give agreeable effects when its beats are very slow. When the chord is more out of tune and the beats become rapid, and mingle in a flutter, whether of 132 a second or more, the ear ceases to regard the sounds as a chord; but it cannot be said that "dissonance must be entirely absent;" on the contrary it is terribly present.

Whether the twenty sounds given above be harmonious or not, it can be shown that this does not depend on the circumstances that there are no coincidences less than 132. For twenty other sounds might be added at random utterly discordant, but not beating slower than 192. For example, 265 : 529, 266 : 530, etc., all having the difference of 264. And in all the examples given, the addition of the overtones does not effect the case, for if the fundamental tones have the desired difference of 132, the first harmonic is sure to have twice this difference, and the others still more. But a point might have been made, which has been overlooked by Tyndall, in the circumstance that these overtones make a "rough" chord more harmonious. See the major third, 4 : 5, 330−264=difference 66, and the minor third, 5 : 6, 396 − 330=difference 66. These are called rough, because their differences are less that 132. But their first harmonics have a difference of 132, and all the following differences are far beyond the assumed limits of dissonance. But the whole theory is untenable.

If the effect is good when each note is accompanied by harmonics, the reason will be found in the simple relations which exist, and in the circumstance that what would be complicated alone, may be clear when auxiliary sounds are present.

After asserting the equality of the musical ratios in composition, I admit the superiority of the simpler ratios for modulations. A change of key is best made to the fifth above or below, by the ratios 2 : 3, or 3 : 4. If the change by an octave, 1 : 2, be considered as a modulation, it is an extremely simple one. But modulations do not seem practicable by a third or seventh, or the primes 5 and 7. Such a change would sound like an abrupt transition.

In rhythm again, no other primes than 2 and 3 have been found available. A single composition has been made with *five* beats, or supposed equal divisions, in the bar, but no one desires to sing it or hear it a second time. It may be said that double time, in general, is more satisfactory than triple; and because

it is simpler. Yet the waltz movement is perfectly clear to most lovers of music. The rhythm which results from joining three doublets or two triplets in a single measure gives an agreeable variety.

Although Professor Tyndall remarks that it is not his "vocation to lead into the musical portion of Acoustics," it is to be wished that so able a man would do so. The physical portion of musical acoustics, and the definition of musical intervals have also been omitted by a late lecturer on Harmony at the Royal Institution (G. A. Macfarren, 1867). Unless the intervals be defined, nothing is to be learned from a lecture on harmony, beyond what can be seen by studying the works of musicians directly. Let the syren be improved so as to give chords with the number 7, and let reed-pipes give the various chords and melodies. Let us know the exact pitch of every note. Musical notation is a sort of short hand, which may not be understood by a mechanical player. One who understands harmony knows what the composer meant in all cases where the composer himself knew it.

South Danvers, Mass., Feb. 1868.

Since writing this paper with regret at the neglect musical science has received, I have had the pleasure of learning that they are doing better in Germany. First, I read the admirable book on the training of the "Voice in Singing," by Mrs. Emma Seiler, late of Heidelberg, and co-laborer with Dr. Helmholtz, in this department, and now established in successful teaching in Philadelphia. Mrs. Seiler has studied the action of the vocal organs from life, and describes the meaning of the "registers" or the several methods of producing tones. She shows how these are to be developed, protected from injury by straining under bad instruction, and made to sing easily and truly. For want of such knowledge we have few good singers. Soprano voices are undeveloped or ruined, and the falsetto register of tenors is no longer used. Yet the great Italian masters used to train tenors with a full and strong falsetto, which united with the chest voice imperceptibly, and continued upward easily and purely. Now the tenors go as high as the chest voice can be painfully urged, and consider it something great if they get up to the *a*. In old times good singers used to preserve their voices to old age. We had here such trained tenors when the English Glees were sung. The following shows that Mrs. Seiler deserves her high reputation as a scientific teacher, and insists on singing in perfect tune.

Purity in the art of Singing is, however, such a primal condition of its beauty, that a piece of music purely executed, even by a weak and slightly cultivated voice, always sounds agreeably, while the most sonorous and practised voice offends the hearer when it is out of tune or forced upward. The training of our singers by pianos, as they are now tuned, by equal temperament, is altogether unsatisfactory. The singer who practices with the piano has no safe principle by which he can measure the height of his tones with any exactness. But persons of good musical talent, made aware of this disadvantage by a competent teacher

and practicing accordingly, can nevertheless overcome this difficulty caused by our present method of tuning, and learn to sing correctly and purely.*

Dr. Feyjoó, who, in his time did most to enlighten Spain, was learned in music, and explained what the "enharmonic" meant. In his convent at Oviedo, in 1734, he thus exalts pure intonation, which is the "unknown charm" of singing, the "*no sè què*," which one has and another has not.

"Could I hear this voice," says he, "I would tell you what is the attractiveness which you call occult. * * * *Perfection of intonation* is a beauty which is occult to the very musicians. Let us not mistake each other. The musicians distinguish very well errors in intonation up to a certain degree; those of a comma, a half comma, or, I will allow you, a quarter comma; so that those who have a delicate ear, although the error is so small, perceive that the voice does not strike with complete exactness, though they cannot tell the amount of the error. But when the error is much less, as the eighth of a comma, no one thinks the voice is not true. But for all that this defect is so small as to escape the reflection of the understanding, it makes a sensible effect upon the ear; and the composition does not please as much as if it were sung by another voice, which should give the intonation more justly. * * * This unknown something, when deciphered, is the just, the perfect intonation."—*Theatro Critico*, tom. vi, p. 432.

I have also just received the large work of Dr. Helmholtz,† of which I can only notice, among much that is highly interesting, that which relates to pure Intonation. He also declares that musical harmonies should be given purely. He has even invented and built a "Harmonium" with perfect tuning. It has 24 notes, and 4 pedals or registers, each controlling 3 notes of a group *a*, and 3 of a group *b*. The key-notes are in a true series of fifths, like my own. Gen. Thompson's enharmonic organ is noticed, and others made in Europe,—nothing from the American side. Notes a comma apart are distinguished by large and small letters as I have done,—originally as I thought,—in this Journal of July last; which plan seems to have been used, previously, by Hauptmann. The harmonic seventh, 4 : 7, is discussed, and in some degree admitted, after ages of constant service in the art, to a place in German musical science; my long neglect of the German language and shortness of time, have not yet allowed me to learn all I would wish about the treatment of this favorite protégé of mine. But there are signs of general progress regarding pure vocal music and its auxiliary instruments, and a rational theory of Harmony.

I am obliged to omit a description of a new "*Enharmonic Vocal Intonator*" for training singers in pure intervals, and for accompanying. It gives full harmonies to the tenth degree—1 : 2 : 3 : 4 : 5 : 6 : 7 : 8 : 9 : 10—plays these chords altogether, or any part of them, and in *arpeggios;* is more easy to play than the guitar and as portable; plays melodies, but chords most easily, being peculiarly constructed for that purpose; has all the harmonies for the major and minor, as in my enharmonic table (this Journal, July, 1867); plays very softly, or loud enough to accompany a choir; and, finally, can be made for the cost of a good guitar. H. W. P.

March 20, 1868.

* The Voice in Singing, translated from the German of Emma Seiler. [By Dr. W. H. Furness.] Philadelphia. 1868.

† Die Lehre von den Tonempfindungen als Physiologische Grundlage für die Theorie der Musik. Von H. Helmholtz. Braunschweig, 1865. 2d ed., 605 pp. 8°.

ART. XXXI.—*On the measurement of wave-lengths by the method of comparison.* Abstract of a paper read before the National Academy of Sciences, Aug. 16, 1867; by WOLCOTT GIBBS, M.D., Rumford Professor in Harvard University.

IN a memoir on the construction of a normal map of the solar spectrum, I have given a method of determining wave-lengths which I believe to be new, and which I have termed the method of comparison. This method is analogous in principle to one frequently employed by astronomers, and consists simply in measuring, upon an arbitrary scale, the distance between the given line and one or more lines, the wave-lengths of which have already been determined. If the relation between the scale-numbers and the corresponding wave-lengths is known, it is easy to determine the wave-length of the given line by calculation.

In the paper above referred to, I have given a complete reduction of Kirchoff's scale, based upon the wave-lengths measured by Ditscheiner. To determine the relation between the scale-numbers and wave-lengths, I employed the graphical method of interpolation, and have given the results in tabular form. In the present paper, I shall give the results of a new reduction of the same scale, in which I have exclusively employed the method of interpolation given by Cauchy, for a knowledge of which I am indebted to Professor Winlock. For the purpose which I had in view this method is very much more convenient and expeditious than that of least squares. The relation between the scale-numbers and wave-lengths is given by an expression of the form

$$\lambda = a + bk + ck^2 + dk^3, \text{ \&c.}$$

In some portions of the scale a parabola of the 5th order is required. In this second reduction I have exclusively employed Ditscheiner's measurements of the wave-lengths, after reducing them, as before, so as to correspond with the value given by Angström for Fraunhofer's line D. As Ditscheiner has given the number of measurements made to determine each wave-length, I have been able to give weights to the wave-lengths employed in the computations. For convenience in discussion, the 106 scale-numbers, the wave-lengths of which are given by Ditscheiner, were divided into twelve groups, nine of which embraced ten measurements for each group, while the tenth group contained twelve, the eleventh eight, and the twelfth seven measurements.

In each group, the initial point is the last scale-number of the preceding series, which is, of course, equivalent to connecting

the ends of the different parabolic curves representing the successive groups.

In Table I, the elements of the computation and the differences between the wave-lengths, as actually measured and as computed by the formulas, are given. Column N gives the number of each element, W the weight, K the scale-number, λ the observed wave-length, and Δ the difference between the observed values of the wave-lengths and the values calculated by the constants given in Table II. It must be borne in mind that the sign + or − refers to the excess or deficiency of the observed over the calculated wave-lengths. The column ε gives the probable error in the case of each group; it may also be considered as expressing the probable error in the determination of any wave-length by the method of comparison, for a particular portion of the scale.

TABLE I.

N	W	K	λ	Δ	ε	N	W	K	λ	Δ	ε
1	9	694·1	656·65	0·00		37	9	1421·5	537·50	0·00	
2	2	711·4	652·07	−0·06		38	9	1450·8	534·49	−0·02	
3	2	719·6	650·03	+0·02		39	18	1463·3	533·27	+0·04	
4	1	783·8	634 23	+0·08		40	6	1492·4	530·21	−0·09	
5	4	831·0	623·59	+0·08		41	6	1506·3	528·77	−0·18	
6	4	849·7	619 60	0·00		42	7	1515·5	527.99	+0·10	
7	7	860·2	617 48	0·00		43	19	1523·7	527·42	+0·07	
8	8	863·9	616·71	−0·04		44	2	1541.9	525 97	+0·20	
9	6	874·3	614 72	0·00		45	8	1569·6	523 72	+0·05	
10	9	877·0	614·23	0·00	±0·04	46	8	1577·6	523·08	−0·05	±0·08
10	9	877·0	614·23	+0·05		46	8	1577·6	523·08	−0·01	
11	7	884·9	612·75	0·00		47	1	1589·1	521·96	−0·21	
12	7	894·9	610·80	−0·06		48	6	1601·7	521·31	+0·12	
13	2	958·8	598·12	−0·02		49	4	1622·3	519 65	+0·03	
14	11	1002·8	590·07	−0·05		50	18	1634·1	518·71	−0·03	
15	18	1006 8	589·43	−0·02		51	14	1648·8	517·68	+0·01	
16	4	1029·3	586·25	+0·35		52	13	1655·6	517·13	−0·05	
17	3	1096·1	576·71	−0·13		53	6	1693·8	514 63	+0·16	
18	3	1102·9	575.77	−0·18		54	4	1737·7	511·41	+0·05	
19	8	1135·1	571·49	+0·06	±0·13	55	4	1750·4	510·28	−0·16	±0·10
19	8	1135·1	571·49	0·00		55	4	1750·4	510·28	−0·02	
20	2	1155 7	568·69	+0·02		56	6	1777·5	508·39	−0·02	
21	10	1174 2	566·32	+0·09		57	5	1799·0	506·89	−0·04	
22	5	1200·6	562·95	+0·07		58	13	1834·3	504·54	+0·03	
23	16	1207·3	561·96	−0·08		59	5	1854·9	503·24	+0·12	
24	9	1217.8	560·75	0·00		60	5	1867·1	502·25	−0·05	
25	8	1231.3	559·12	0·00		61	2	1873·4	501·66	−0·23	
26	7	1242·6	557·76	0·00		62	7	1885·8	501·05	−0·01	
27	10	1280·0	553·25	−0·06		63	4	1908·5	499 70	+0·12	
28	1	1303·5	551·11	+0·59	±0·16	64	6	1920·2	498·76	−0·07	±0·08
28	1	1303 5	551·11	+0·28		64	6	1920·2	498·76	0·00	
29	2	1306·7	550·68	+0·26		65	17	1960·8	496·14	+0·01	
30	12	1324.8	548·11	−0·07		66	2	1975·7	495·03	+0·08	
31	3	1337·0	546·76	+0·02		67	7	1983·3	494 33	0·00	
32	8	1343·5	546·03	+0.04		68	6	1989·5	493.75	−0·05	
33	5	1351·1	545·06	−0·07		69	7	2005·2	492.31	−0·15	
34	10	1367 0	543·40	+0·04		70	3	2118·5	491.39	+0·07	
35	11	1389·4	540·90	−0·04		71	9	2041·3	489 52	+0·09	
36	1	1410·5	538·77	+0·09		72	2	2058·0	488·16	0·00	
37	9	1421·5	537·50	0·00	±0·12	73	9	2067·1	487·53	0·00	±0·06

TABLE I—(Continued).

N	W	K	λ	Δ	ε	N	W	K	λ	Δ	ε
73	9	2067·1	487·53	−0·03		93	1	2547 2	450·12	+0·44	
74	21	2080·0	486·49	+0·06		94	9	2566·3	448.45	−0·05	
75	1	2103.3	484·62	+0·32		95	7	2606·6	445·99	+0·05	
76	8	2119.8	482·80	−0·16		96	4	2627·0	444·63	0·00	
77	1	2148·9	480·54	+0·23		97	7	2638·6	443·83	−0·05	
78	1	2157.4	479·53	−0·03		98	8	2670·0	441·87	−0·01	
79	3	2160.6	479·21	−0.19		99	7	2686·6	440 86	+0·01	
80	6	2187·1	476·92	−0·18		100	12	2721·6	438·74	0·00	±0·15
81	3	2201·9	475·89	+0·09							
82	2	2221·7	474·33	+0·22							
83	5	2233·5	473·35	+0·30							
84	2	2250·0	471·24	−0·38	±0·22						
84	2	2250·0	471·24	+0·02		100	12	2721·6	438·74	+0·15	
85	4	2264·3	470·69	+0·05		101	7	2734·9	437·79	+0·09	
86	12	2309·0	467 06	−0·02		102	8	2775·7	435·66	+0·14	
87	5	2416·0	460·61	+1·06		103	11	2797·0	434·32	−0·33	
88	5	2436·5	458.65	+0·34		104	11	2822·8	433·80	+0.23	
89	3	2457·5	456·80	+0·18		105	17	2854 7	431·34	−0·25	
90	6	2467·6	455·70	−0·20		106	7	2869·7	430·36	+0·26	±0·28
91	8	2489·4	453·71	−0·66							
92	2	2537.1	450·54	−0·46							
93	1	2547·2	450·12	−0 17	±0·66						

Table II* gives the values of the constants *a*, *b*, *c*, *d* and *e*, as deduced from the elements given in Table I. In this table column 1 gives the initial and column 2 the terminal point upon Kirchoff's scale for each curve. It will be remarked that, in one instance, the observations are best represented by a straight line.

TABLE II.

	1	2	*a*	*b*	*c*	*d*	*e*
1	694·1	877	656·65	−26·325	+1·0490	+0·3618	.....
2	877	1135·1	614·19	−17·670	−5·5610	+4·6190	−0·8910
3	1135·1	1303·5	571·47	−14·008	+1·5466	−0·3707	.....
4	1303·5	1421·5	550·82	−12·842	+2·1860	−0·7367	.....
5	1421·5	1577·6	537·49	−10·063	−0·6920	+0·7960	.....
6	1577·6	1750·4	523·09	− 8·125	+0·8911	−0·2463	.....
7	1750·4	1920·2	510·30	− 6·792	−0·1661	+0·1180	.....
8	1920·2	2067·1	498·76	− 5·029	−3·4550	+1·6630	.....
9	2067·1	2250·0	487·45	− 5·026	−8·9870	+7·7820	−2·190
10	2250·0	2547·2	471·24	− 7·048	.....	.....	.....
11	2547·2	2721.6	449·67	− 6·154	−0·4536	+0·2028	.....
12	2721·6	2869·7	438·58	− 8·129	+2·1490	+1·5740	−1·6350

A very slight examination of the column of differences, in Table I, will serve to show the marked irregularity of certain portions of Kirchhoff's scale. It is worthy of notice that this irregularity occurs, for the most part, precisely in those portions of the scale which we should expect *a priori* to find most

* In using the constants in Table II for computing wave-lengths the value of *k* is to be found by subtracting the initial number in column 1 from the scale number and dividing the remainder by 100.

uniform; it is, however, easily explained by the frequent variations in the position of the prisms in the spectroscope employed. It is not to be denied that the advantages of the method of comparison in the determination of wave-lengths will more fully appear when an extended spectrum shall have been drawn with the data yielded by a spectroscope in which, as in that of Mr. Rutherfurd, all the prisms are in the position of least deviation for each ray in succession.

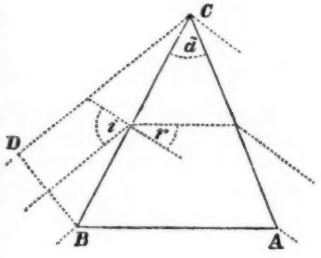
In my former paper, I have given a method of comparing a given spectrum directly with Kirchoff's chart, by means of a particular arrangement of the scale telescope. I have since found that it is simpler and better to employ a camera lucida attached to the eye piece of the observing telescope. The chart is placed upon the table below and serves to identify the lines. To find the position of a single line, as for instance the green thallium line, upon the chart by comparison, one-half of the slit of the collimator must receive direct sunlight while the other half receives the light of the flame containing thallium, the camera lucida and chart being adjusted in the manner already described. A filar micrometer may, also, be employed with great advantage whenever the field of view contains, at the same time, the line the wave-length of which is to be determined, and one or more other lines of which the wave-lengths are known, or which can be identified upon the chart by means of the camera lucida.

Cambridge, March 6, 1868.

ART. XXXII.—*On the Comparative Efficiency of different forms of the Spectroscope;* by EDWARD C. PICKERING.

IT is the object of the present paper to furnish a means of comparing with accuracy spectroscope prisms of different forms, and to determine what must be their refracting angle, to produce the greatest dispersion, with the least loss of light. We have then to consider the dispersion, the loss by reflection, and that by absorption.

1. *Dispersion.*—The dispersion of any part of the spectrum, is proportional to the angular interval between two rays of nearly equal refrangibility, as the two parts of a double line.



Let α be the refracting angle of the prism ABC, n the index of refraction of the less refrangible ray. For minimum deviation,

$r=\frac{\alpha}{2}$, $\sin i=n\sin\frac{\alpha}{2}$ . . . . . (1). If dn be the difference of the indices of refraction of the two rays, di will be their angular divergence. Differentiating (1), $di=\frac{\sin\frac{\alpha}{2}}{\cos i}dn=\frac{1}{n}\tan i\,dn$ . . (2), in which $\frac{1}{n}\tan i$ serves as a measure of the dispersion under different angles of incidence. It differs essentially (when the angle of incidence is large) from the deviation which is commonly, but incorrectly, assumed as the measure.

Comparative dispersion and deviation of a ray entering a medium in which $n=1{\cdot}5$.

Angle of incidence i,	0°	15°	30°	45°	56° 19′	60°	75°	80°	85°	90°
Dispersion $\frac{1}{n}\tan i$,	·0	·179	·385	·667	1·000	1·1565	2·488	3·781	7·620	∞
Deviation $i-r$,	0°	5° 4′	10° 32	16° 53′	22° 38′	24° 44′	34° 55′	38° 58′	43° 23′	48° 11
" reduced to same unit as dispersion,	·0	·231	·465	·746	1·000	1·093	1·543	1·720	1·917	2·121

The dispersion then increases much more rapidly than the deviation; hence in spectroscopes whose deviation is the same, that one will disperse most, in which i and therefore α is the greatest.

The above discussion applies strictly only to the emergent ray, but in the position of minimum deviation, the dispersion of a prism is just double this, as may be seen from the general formula for dispersion (Radicke's Optics, vol. i, p. 179). I propose hereafter to discuss the question whether greater dispersion with the same loss of light could not be obtained by some other position of the prism.

2. *Reflection.*—In estimating the loss by reflection it is usual to assume that the same proportion of the incident light is lost at each successive refraction. But in reality the light so refracted is partially polarized, and in this state another law determines the amount reflected. Fresnel showed that of a ray polarized in the plane of incidence, the proportion reflected $B'=\frac{\tan^2(i-r)}{\tan^2(i+r)}$, while a ray polarized in a plane perpendicular to the first, would lose by reflection $A'=\frac{\sin^2(i-r)}{\sin^2(i+r)}$.

Regarding common light as composed of two beams of equal intensity polarized at right angles, the amount reflected would be $\frac{1}{2}A'+\frac{1}{2}B'$, and that transmitted $\frac{1}{2}[(1-A')+(1-B')]$. On meeting a second surface inclined at the same angle of inci-

dence, the amount transmitted would be $\frac{1}{2}[(1-A')^2+(1-B)^2]$ and after passing m surfaces $\frac{1}{2}[(1-A'^m)+(1-B')^m]$.

This formula can be applied directly to the m surfaces of the prisms of a spectroscope, since in the position of minimum deviation i and r are the same for all, and therefore the amount transmitted is the same, whether the passage is from glass to air, or from air to glass.

The formulas of Fresnel are used in preference to those of Cauchy, although the latter have been proved, by Jamin and others, to be more correct. But the coefficient of ellipticity which they involve is neither so commonly, nor so easily found as the index of refraction. Furthermore, for glass the difference would probably be so small that it could be neglected.

3. *Absorption.*—The average length of glass traversed by the light is one half the base AB, multiplied by N the number of prisms, and the amount escaping absorption is proportional to the log. of this distance, or to $\log N \times BC \sin\frac{1}{2}\alpha$, or in prisms admitting the same amount of light (that is in which BD is the same) to $\log BD \times N \frac{\sin\frac{1}{2}\alpha}{\cos i}$, since $BC = \frac{BD}{\cos i}$, but the dispersion is proportional to $N\frac{\sin\frac{1}{2}\alpha}{\cos i}$, hence in spectroscopes dispersing equally and composed of prisms of the same material, *the loss by absorption will be the same in all*, so that as far as the absorption is concerned, it makes no difference whether a spectroscope is composed of a large number of very acute angled prisms, or of a less number in which the angle is more obtuse.

Thus we avoid a difficulty which seemed at first sight insurmountable, since the actual amount of light absorbed varies not only with the material, but with the refrangibility of the rays, and according to laws not yet discovered.

The following tables give the deviation, dispersion, and amount of light escaping reflection, of spectroscopes composed of from one to ten prisms of indices of refraction 1·5, 1·6 and 1·7.

TABLE I.—45° *Prisms.*

	n	1 surface.	1 prism.	2 p.	3 p.	4 p.	5 p.	10 p.
Deviation $i-\frac{\alpha}{2}$	1·5	12° 32′	25° 4′	50° 8′	75° 12′	100° 16′	125° 20′	250° 40′
	1·6	15° 15′	30° 30′	61° 0′	91° 30′	122° 0′	152° 30′	305° 0′
	1·7	18° 5′	36° 10′	72° 20′	108° 30′	144° 40′	180° 50′	361° 40′
Dispersion $\frac{\sin\frac{\alpha}{2}}{\cos i}$	1·5	·467	·935	1·870	2·804	3.739	4·674	9·348
	1·6	·484	·968	1·936	2·904	3·872	4.840	9·680
	1·7	·504	1·008	2·016	3·023	4·031	5·039	10·078
Transmitted $\frac{1}{2}[(1-A')^m+(1-B')^m]$	1·5	·957	·916	·841	·774	·724	.661	·461
	1·6	·943	·892	·799	·719	·651	·592	·391
	1·7	·926	·859	·745	·653	·578	·516	·324

TABLE II.—60° *Prisms.*

		1 surface.	1 prism.	2 p.	3 p.	4 p.	5 p.	10 p.
Deviation	1·5	18° 35′	37° 10′	74° 20′	111° 30′	148° 40′	185° 50′	371° 40′
	1·6	23° 8′	46° 16′	92° 32′	138° 48′	185° 4′	231° 20′	462° 40′
	1·7	28° 13′	56° 26′	112° 52′	169° 24′	225° 44′	282° 10′	564° 20′
Dispersion	1·5	·756	1·512	3·023	4.535	6·046	7·558	15·116
	1·6	·833	1·667	3·334	5·000	6·667	8·334	16·668
	1·7	·949	1·899	3·797	5·696	7·594	9·493	18·986
Transmitted	1·5	·945	·895	·811	·742	·686	·641	·509
	1·6	·920	·853	·748	·672	·618	·578	·491
	1·7	·888	·801	·681	·608	·565	·538	·505

TABLE III.—*Angles of Prisms* 67° 22′, 64° *and* 60° 56′.

Deviation	1·5	22° 38′	45° 16′	90° 32′	135° 48′	181° 4′	226° 20′	452° 40′
	1·6	26°	52°	104°	156°	208°	260°	520°
	1 7	29° 4′	58° 8′	116° 16′	174° 24′	232° 32′	290° 40′	580° 20′
Dispersion	1·5							
	1·6	1.	2.	4.	6.	8.	10.	20.
	1·7							
Transmitted	1·5	·923	·863	·763	·691	·639	·600	·520
	1·6	·899	·818	·702	·629	·582	·552	·505
	1·7	·874	·780	·657	·588	·549	·523	·501

Table I applies to prisms of 45°. Table II to those of 60°, these being the forms in general use, and Table III. where the angle is such that the reflected light would be totally polarized, α being 67° 22′, 64°, and 60° 56′ in the three cases respectively. This form of prism appears to present great advantages for large spectroscopes, since at most but one half of the light can be reflected, while one prism disperses as much as two of 45°.

To apply these tables to an example, let us compare three spectroscopes of ten prisms each of angles 45°, 60° and 64°, the index of refraction being 1·6.

10 prisms of	Deviation.	Dispersion.	Transmitted.	Trans $\times \cos i$.
45°	305° 0′	9·680	·3911	·308
60°	462° 40′	16·668	·4912	·294
64°	520°	20·000	·505	·268

Again, comparing spectroscopes producing equal deviation,

	Deviation.	Dispersion.	Transmitted.	Trans. $\times \cos i$.
12 prisms of 45°	366°	11·616	·339	·268
8 " " 60°	370° 8′	13·334	·532	·319
7 " " 64°	364°	14.	·521	·276

From the first example we see that by using 64° prisms instead of 45° we obtain more than double the dispersion, with even less loss of light, while in the second case seven 64° prisms prove much more efficient than twelve of 45°.

All these calculations seem to point to the superiority of

60° prisms, over those of 45°. A much greater angle is objectionable from the increased distortion produced by the slightest imperfection in the refracting faces.

In prisms admitting the same amount of light the more acute the angle, the less is the quantity of glass and the less the area of each face. The ground might be taken that a 45° prism could be made larger than one of 60° at the same expense, and thus the difference in light remedied. In this case, however, it would be necessary to enlarge the telescope, number of prisms, and in fact the whole instrument. Even supposing this change made, the prisms of larger angle preserve their superiority, though not in so marked a degree. The calculation is readily made by multiplying the transmitted light by cos i, as is done in the above examples.

The index of refraction varying with the refrangibility of the rays, the dispersion, loss of light, &c., would vary in different parts of the spectrum. The change would, however, be small, and could be determined, if necessary, by merely altering n.

Institute of Technology, Boston, Feb. 29th, 1868.

Art. XXXIII.—*Contributions to Mineralogy.*—No. VII; by F. A. Genth.

During the last year or two, I have been engaged with the investigation of several very rare minerals, the composition of which was but little known, or doubtful, principally from localities on the Pacific coast.

In some instances, the results which have been obtained, although sufficient to establish with great probability the true nature of the species, represented, on account of the great scarcity of material, the composition of mixtures of several minerals. As for instance with the California tellurids, of which I have for a long time in vain endeavored to procure larger quantities of pure material, but despairing to find any, I had already written out my results for publication, when about two months ago, through the kindness of several friends, I was so fortunate as to obtain of these interesting minerals, minute, but *perfectly pure* fragments, which enabled me to renew my examinations and in this manner partly to corroborate, partly to correct results, which had previously been obtained, and also to establish an interesting *new* species. I will now proceed with the results of my investigation.

1. *Whitneyite.*—About three years ago a specimen of this mineral was brought to the Hon. N. S. Higgins, then at the

Cerro Colorado mine, Southern Arizona, under the impression that it contained a large amount of silver, and he was requested to ascertain the value of the ore. To the great disappointment of the owner he recognized it as an arsenid of copper, and found in a pure fragment of it, 11·59 per cent of arsenic, which proved that it was Whitneyite. He secured the specimen, which he kindly presented to me.

In its crystalline structure and color, it has exactly the appearance of specimens, furnished by the original locality, the Pewabic mine, Michigan. It is somewhat intermixed with a hornstone-like mineral. The analysis gave, after deducting 9·52 per cent of hornstone, etc.:

Copper,	88·54 per cent.
Silver,	*a trace*
Arsenic,	11·46 "

From La Lagoona, a rancho on the road to Libertad, about 35 miles from Saric, Sonora, where it is said to exist in considerable quantities.

2. *American Tellurium minerals.*—The first discovery of a tellurid in this country is due to Dr. C. T. Jackson (this Journ. [II], vi, 188), who from some preliminary examinations supposed that from the Whitehall mine, Spotsylvania Co., Va., which had been mistaken for molydenite, to be *foliated tellurium.*

A short time afterward a mineral was discovered at a gold mine in Fluvanna Co., Va., which much resembled that from the Whitehall mine. It was analyzed by Mr. Coleman Fisher, Jr. (this Journ. [II], vii, 282), who recognized it as a "*telluret of bismuth,*" containing a *large percentage of selenium.*

In a subsequent publication (this Journ. [II], x, 78), Dr. Jackson corrects his first statement and gives the result of an analysis, showing the Whitehall mineral to be *tetradymite* and *not* foliated tellurium.

In his paper he also observed the occurrence of *yellow oxyd of bismuth,* investing the nodules of the tellurium ore, which is *not* carbonate of bismuth, for it does not effervesce with acids.

In the year 1850, I discovered *tetradymite* in Davidson Co., N. C., of which I published a description and analysis (this Journ. [II], xvi, 81). I mention as associated with it a mineral, resulting from its oxydation, containing *telluric acid.*

In my Contributions to Mineralogy (this Journ. [II], xix, 15), I show that the mineral from Fluvanna Co., Va., analyzed by Mr. Coleman Fisher, Jr., contains *no* appreciable quantity of *selenium* but is a *pure tertellurid of bismuth.*

As new localities of tetradymite I mention the Phoenix mine and Boger mine, Cabarrus Co., N. C.

Several localities at which tetradymite was found, were given by Prof. C. U. Shepard, one in the Chestatee river near Dahlonega, Lumpkin Co., Ga., then the Pascoe mine, Cherokee Co., and another near Van Wort in Polk Co., Ga. (this Journ. [II], xxvii, 39).

The discovery of *bornite* at Field's gold mine, near Dahlonega, Ga., was announced by Dr. Jackson ([II], xxvii, 366). This I proved subsequently to be erroneous (Mining Magazine, [II], i, 358), showing the mineral, like that from Fluvanna Co., Va., to be *tertellurid of bismuth*, which opinion was fully corroborated by a reëxamination of the same mineral by Mr. David M. Balch, (this Journ. [II], xxxv, 99).

These are, as far as I can ascertain, all the localities at which tellurium minerals have been found in the Atlantic States, and they represent only the *one* species, tetradymite, but in its *two* well established varieties.*

The Pacific States have lately furnished a far greater variety and in fact, with the exception of *sylvanite*, all the known tellurium minerals have been found there, together with several *new* ones.

Prof. W. P. Blake was the first who reported the occurrence of tellurium ores in California (Geological Reconnoissance in California, 302) (this Journ. [II], xxiii, 270), stating that a mineral containing tellurium and silver, probably hessite, had been washed out from a gold drift near Georgetown, Eldorado Co., Cal.

The next information which was published about California tellurium ores, is contained in a pamphlet on the "New Melones Gold and Silver Mines," in which appears a Report of Mr. Charles A. Stetefeldt on the Reduction of Telluric Gold and Silver Ores, an abstract of which was published in the Berg. und Hüttenmännische Zeitung, Oct. 30, 1865. Stetefeldt remarks that "*the samples of ore from the Stanislaus mine contain large quantities of sylvanite or graphite tellurium of steel-gray color and metallic luster, by far the richest tellurium ore, and smaller quantities of the tellurium of lead, recognizable by its tin-white color and great luster.*"

Mr. Guido Küstel describes in the Mining and Scientific Press of San Francisco, of May 20th, 1865, the principal ore of the Melones mine, "tellurite (!) of silver-gold as a new species, gives its specific gravity as from 9 to 9·4 and the compo-

* In Dana's System of Mineralogy, ii, 64, it is mentioned that minute crystals, which I had observed to occur with gold ores at Gold Hill, Rowan Co., N. C., were probably *sylvanite*; subsequent examination, however, proved them to be *bismuthine*.

sition, determined by blowpipe analysis as follows: Au=24·80, Ag=40·60, Te=35·40 (?). In a communication dated San Francisco, Jan. 4, 1866 (Berg. und Hüttenmännische Zeitung, 1866, 128), he states that he has neither observed sylvanite nor tellurid of lead, but besides the principal ore, of which he gives his previous results (misprinted 21·80 instead of 24·80), tellurid of silver, native tellurium, copper-nickel (!? Genth) pyrites and free gold.

Mr. Jas. Ross Browne in his Report on the Mineral Resources of the States and Territories West of the Rocky Mountains, Washington, 1867, published W. P. Blake's catalogue of March, 1866, in which the latter states that at the Stanislaus and Melones mines, "*very beautiful specimens of gold associated with tellurium were taken out of a vein from* 6 *to* 18 *inches thick, and at a depth of* 200 *feet from the surface. This telluret has a tin-white color and is not foliated like the tetradymite of the Field vein in Georgia. Its exact specific character is not yet determined.*"

At the meeting of the Academy of Nat. Sciences in Philadelphia, of August 6th, 1867, I have made some observations referring to the progress of my investigations, and announced the occurrence of a new mineral, tellurid of nickel, at the Melones mine.

In a private communication, dated Helena, Montana Territory, Nov. 25, 1867, Mr. J. L. Kleinschmidt informs me, that about two months previously, he had received from Prof. Swallow a mineral of the appearance of bismuth, which attracted his attention by its pale gray color and bright luster. A preliminary examination gave lead, silver, gold and tellurium. No further examination having been made, nothing can be said as to its true nature.

Prof. B. Silliman mentioned at the session of Dec. 2, 1867, of the California Acad. of Sciences, the occurrence of tellurium ores at *three new* localities—at the Golden Rule mine on the mother lode near Poverty Hill, Tuolumne Co., where ores similar to those of the Melones mine are found in thread-like quartz veins, crossing the cleavage of argillite, at the Raw Hide rancho mine and at the Reist mine on the mother lode at Whisky Hill, Tuolumne Co., where he discovered a very small crystal of hessite. In one of the mines at Angel's camp he observed foliated tellurium.

On the 5th of Dec. 1867, Mr. Kleinschmidt writes me from Helena, that he had discovered in placer gold from Highland, Montana Territory, gray metallic scales which he found to contain tellurium and bismuth. He very liberally placed the whole quantity which he had secured, into my hands for further investigation.

This brief review contains, I believe, all that has been communicated with reference to the occurrence and composition of tellurium minerals in this country, and it will be seen from it that very much doubt existed as to the real nature of the California minerals. I was very anxious therefore, to submit them to a thorough chemical examination.

To Dr. Theodore F. Moss, I am indebted for the first two pieces from the Stanislaus mine, Calaveras Co., Cal., which I have received, and which have furnished very important material for this investigation, one containing the tellurid of nickel (melonite), in the purest condition, in which I have seen it, only very little mixed with hessite, and the other, principally hessite, but mixed with more or less melonite.

The next and also very valuable specimen from the Stanislaus mine, was brought from California by the Hon. N. S. Higgins. It contained the tin-white altaite, in some portions so intimately mixed with hessite that, before I had obtained a pure specimen of altaite, I thought it might be a new species. It also contained foliated melonite, and minute specks of a mineral, which may be native tellurium.

My analyses had to be made with the cleanest that could b selected from the very much mixed material of these three pieces, but they were at once, as far as possible, repeated, when I received through the kindness of Dr. I. Adelberg and Messrs. Louis Beckers and Jas. B. Hodgkin of New York, and E. Balbach, Sr., of Newark, N. J., specimens from the Stanislaus mine, which gave me minute quantities of perfectly pure altaite, the highly auriferous hessite (petzite), and of the new and interesting mineral calaverite.

The tellurium ores of the Stanislaus mine occur in talcose and chloritic slates, associated with quartz, dolomite, ? apatite, a uranium mineral, titaniferous iron, pyrites, chalcopyrite, small quantities of galena, blende, and free gold. In the specimens which I have seen, neither of these mineral forms in the quartz or dolomite larger patches ; they are generally present in small particles only, and so much mixed together, that but two pieces furnished the pure material, which I could obtain for examination.

I had just finished my investigation of the tellurids from the Stanislaus mine, when I received for examination, through the kindness of Professors B. Silliman, Dana and Brush, a specimen of petzite from the Golden Rule mine, Tuolumne Co., Cal. It is associated with minute quantities of altaite, gold and pyrites, with quartz and dolomite in argillaceous slate. The specimen furnished perfectly pure material for analysis.

a. Petzite and Hessite.—Of all the tellurium minerals, which have been observed in California, that variety of tellurid of

silver, in which a large portion of silver is replaced by gold, the so-called petzite, appears to be the most common.

The specimens which I have examined, both from the Stanislaus mine and from the Golden Rule mine, were without crystalline structure, showed a distinct conchoidal fracture, metallic luster and a color between dark steel gray and iron black, sometimes tarnished with pavonine colors. Brittle, soft, hardness about 2·5, sp. gr. according to Küstel 9—9·4. Streak, iron black.

B.B. with soda gives a bluish green flame and yields a silver globule of a yellowish white color. If a fragment is placed upon a hot coin, or is very cautiously heated with the blowpipe, the dark steel-gray color changes into a dull yellow, from the separation of gold globules, as observed by Küstel. Nitric acid turns it black at once, and dissolves it slowly with the separation of metallic gold; aqua regia dissolves it with the separation of chlorid of silver.

The material for the analyses, highly magnified, was found to be free from admixtures with the exception of a minute quantity of quartz, which was deducted as follows: from analysis I, 2·60 p. c., from II, 0·99 p. c., from IV, 0·48 p. c., and from V, 0·59 p. c.

	Stanislaus Mine.			Golden Rule Mine.	
	I.	II.	III. (Küstel).	IV.	V.
Gold,	25·55	25·70	24·80	25·60	24·97
Silver,	41·93	42·36	40·60	41·86	40·87
Tellurium,	32·52*	31·94*	35·40?	32·68	34·16*
	100·00	100·00	100·80	100·14	100·00

These analyses correspond closely with the composition, expressed by the formula: AuTe+3AgTe, which requires:

Au,	197	25·35
3Ag,	324	41·70
4Te,	256	32·95
	777	100·00

This variety of auriferous tellurid of silver is closely allied to that from Nagy-Ag, analyzed by Petz, but it contains a considerably higher percentage of gold. The analysis of Petz agrees nearly with the formula 2AuTe+9AgTe, the ratio between Au : Ag being 1 : 4·7, whilst that of the California mineral is 1 : 3.

Notwithstanding this difference in composition, they should *not* be considered as different species, gold being capable of replacing silver in variable quantities, I adopt therefore, Haidinger's name "Petzite," for *all varieties* of telluric silver, in which a large portion of silver is replaced by gold.

* From the loss.

Not all the tellurid of silver from the Stanislaus mine, however, is petzite; there occurs also the other variety, which does not contain any, or only a very small percentage of gold, as already observed by Küstel.

The *true* hessite, or the variety more approaching to it, is of a darker color and seems not to form larger particles, but to be more finely disseminated through the matrix, often between the cleavage planes of dolomite.

I have not been able to obtain it for my analyses in a state of purity. It was mixed with other tellurids, with quartz, dolomite and free gold. For the purpose of analyzing it, the mixed material, coarsely powdered, was treated with warm dilute chlorhydric acid to remove the dolomite, then picked out again, after having been thoroughly washed, but it was impossible to obtain it free from quartz, tellurid of nickel and free gold.

It was necessary, therefore, for the purpose of ascertaining the condition in which the gold was present, whether as tellurid or free gold, to make a careful analysis of the free gold associated with the Stanislaus mine tellurids, and from the amount of silver remaining with the gold, after treating the mineral with nitric acid, both the amount of free gold and that of tellurid of gold was determined. The free gold contains:

Gold,	88·63 per cent.
Silver,	11·37 "
	100·00

The purest hessite (I), after deducting 7·21 p. c. of admixtures, of which 4·22 p. c. were of free gold and the balance quartz, and a less pure specimen (II), which contained 28·60 p. c. of admixtures, of which 6 p. c. were of free gold, gave:

	I.	Requires Te.	II.	Requires Te.	
Gold,	3·28	1·06	3·22	1·05	for AuTe
Silver,	46·34	27·45	55·60	32·95	" AgTe
Lead,	1·65	1·02	----	----	" PbTe
Nickel,	4·71	15·32	1·54	5·01	" Ni_2Te_3
Tellurium,	44·45		39·64*		
	100·43	44·85	100·00	39·01	

This would be equal to:

	I.	II.
Hessite,	78·11	92·82
Altaite,	2·67	----
Melonite,	20·03	6·55

Ratio of Au : Ag in the hessite in I = 1 : 25; in II = 1 : 31.

There certainly exists also the variety of hessite, which is *entirely free* from gold; that which was mixed with the impure

altaite, III, and with the melonite (see below), did not contain any, and the material for analysis when dissolved in nitric acid, did not separate any brown gold, it contained, therefore, the *true* hessite.

b. Altaite.—This very rare mineral also occurs at the Stanislaus mine as already observed by Charles A. Stetefeldt, and it appears to be the mineral to which W. P. Blake refers in his catalogue. I noticed it in minute quantities with the petzite from the Golden Rule mine.

It is easily distinguished from the other tellurids by its tin-white color, which has a slight but distinct greenish yellow hue. Tarnishes with a bronze yellow color. Cleavage distinctly, in some pieces eminently cubical. Exceedingly brilliant metallic luster. Hardness below 3. Streak gray.

Analysis I was made with an almost pure piece; after deducting 1·03 p. c. of quartz, and 1·96 p. c. for II, which was less pure, I obtained:

	I.	Requires Te.	II.	Requires Te.
Lead,	60·71	37·54	47·84	29·58
Silver,	1·17	0·69	11·30	6·70
Gold,	0·26	0·08	3·86	1·25
Tellurium,	37·31		37·00*	
	99·45	38·31	100·00	37·53

These analyses would represent the composition of the two specimens as:

Altaite,	99·25	77·42
Hessite,	2·20	23·11

Before I had the purer varieties of altaite, from which the two last analyses were made, I analyzed some from the piece presented by Mr. Higgins. It gave results which were, in several points of view, of interest. After, from the purest that could be found, the carbonates had been removed by dilute chlorhydric acid and it had been completely washed, it was pulverized and the lighter portion washed off. The heavier portion gave after deducting 8·00 p. c. of free gold and 3·45 p. c. of quartz:

(Mixture of altaite and hessite) III.

Silver,	44·49	requiring Te 26·36
Lead,	18·37	" " 10·89
Tellurium,	37·14*	
		37·25

This mixture contains, therefore, 70·85 p. c. of *true* hessite and 29·26 p. c. of altaite.

This result was quite surprising, since the material appeared to be comparatively pure, at any rate seemed to contain a far larger percentage of altaite.

Future investigations will be necessary to ascertain whether there really exists a tellurid of silver, or tellurid of silver and lead, which has the white color and cubical cleavage of the altaite.

c. ? Native tellurium.—I have above already mentioned, that the specimen brought by Mr. Higgins contained minute specks of a mineral which may be native tellurium. The quantity which I have observed is microscopic. They have a grayish-white color.

According to Küstel, native tellurium occurs at the Stanislaus mine. That these greyish-white specks might be native tellurium has been suggested by the results of the analysis of the light washings from the last mentioned analysis. They contained 94·23 p. c. of quartz and other insoluble substances, but no gold, and 5·77 p. c. of tellurium minerals, showing the following composition:

Ag,	30·75	requiring Te	18·23=48·98 p. c.	*true* hessite
Pb,	26·94	"	16·66=43·60 "	altaite.
Te,	42·31		7·42 "	tellurium.
	100·00		34·89	

This leaves an excess of 7·42 p. c. of tellurium, which may be present in the native state. This becomes the more probable, if we take into consideration the far lower specific gravity of this substance. The analysis of melonite also gives a slight excess of tellurium, which may be due to an admixture of the native metal.

d. Melonite.—*A new mineral*, Ni_2Te_3(?), hexagonal. I observed one microscopic, but perfect six-sided plate; generally in indistinct granular and foliated particles, with eminent basal cleavage. Luster metallic, color reddish-white, similar to that of bismuth, tarnishes rarely, with a brownish color. Streak, dark gray. B.B. in a tube gives a sublimate fusible into colorless drops, leaving a gray mass; on charcoal, it burns with a bluish flame giving very little white volatile incrustations and leaving a grayish-green residue, which in the inner flame with soda yields a gray magnetic powder of metallic nickel. Dissolves in nitric acid with a green color, yields on evaporation a white crystalline powder of tellurous acid; addition of ammonia gives a clear blue solution.

This appears to be one of the rarest of the tellurids of the Stanislaus mine. Only one of the specimens which I have received contained enough of the mineral to make an analysis of it, and this was mixed with quartz, and small quantities of hessite, altaite and possibly of native tellurium. After deducting 22·22 p. c. of quartz and 3·26 p. c. of free gold, I obtained:

		Requires Te.	
Silver	4·08	2·42	6·50 p. c. of *true* hessite.
Lead	0·72	0·45	1·17 " altaite.
Nickel	20·98	68·27	89·25 " melonite.
Tellurium	73·43		2·29 " nat. tellurium.(?)
	99·21	71·14	

The nickel from all my analyses contained just enough cobalt to color a borax bead very slightly blue.

From this analysis as well as from the two analyses of hessite given above, the formula of the melonite appears to be Ni_2Te_3. Although the hexagonal form would better agree with the formula NiTe and bring the melonite into the same group with millerite, pyrrhotine, greenockite, etc., it is not very probable that it is a mixture of native tellurium and NiTe, because it would have contained about one third of native tellurium. The material for analysis, however, strongly magnified showed distinctly a small quantity of the dark colored hessite, and every other particle showed the reddish hue, but *not the slightest* admixture of a greyish white mineral could be observed.

The composition of melonite, corresponding with Ni_2Te_3 would be:

2Ni	59	=	23·51
3Te	192		76·49
	251		100·00

e. *Calavērite, a new mineral,* $AuTe_4$.—I have only observed it once, associated with petzite, on a specimen from the Stanislaus Mine.

Massive, without crystalline structure. Soft. H. below 3. Brittle. Luster metallic. Color bronze yellow. Streak yellowish gray. Fracture uneven, inclining to subconchoidal.

B.B. on charcoal burns with a bluish green flame and yields globules of gold of a *high* yellow color. Nitric acid darkens it and separates metallic gold; aqua regia dissolves it with the separation of a minute quantity of chlorid of silver. The material for the analyses when strongly magnified appeared to be perfectly pure. In II, 1·45 pr. ct. of quartz were deducted.

	I.	II.
Gold	40·70	40·92
Silver	3·52	3·08
Tellurium	55·89	56·00*
	100·11	100·00

Associated and frequently mixed with the calaverite is petzite. Although the material for analyses appeared perfectly

pure, from an admixture of petzite probably results the greater portion of the silver, but a minute quantity is certainly replacing a portion of the gold, because, if the whole amount of silver with the corresponding quantity of gold (41·70 : 25·35) is taken as petzite, both analyses would give only about 97 pr. ct. The ratio between gold and tellurium (after deducting the silver as petzite) is 1 : 4·2 or nearly 1 : 4, the most probable formula for calaverite is therfore $AuTe_4$, which in its pure state would have the composition :

Au	197	44·47
$4Te$	256	55·53

A comparison between the analyses of the calaverite and those of the Transylvania sylvanite leads to very interesting suggestions. Under the name sylvanite, *two* distinct minerals are generally treated; one, the so-called "graphic tellurium," for which the name "sylvanite" may remain, and the "weisstellur" and "gelberz."

The most recent and reliable analyses of these minerals were made by Petz, who found in the graphic tellurium from Offenbanya :

	I.	II.
Tellurium	59·97*	58·81*
Antimony	0·58	0·66
Gold	26·97	26·47
Silver	11·47	11·31
Copper	0·76	----
Lead	0·25	2·75

Of the varieties weisstellur and gelberz from Nagy-Ag, he analyzed : I, long crystals of a white color; II, thick crystals ; III, short yellowish crystals; IV and V, massive bronze-yellow mineral :

	I.	II.	III.	IV.	V.
Tellurium	55·39	48·40	51·52	44·54	49·96
Antimony	2·50	8·42	5·75	8·54	3·82
Gold	24·89	28·98	27·10	25·31	29·62
Silver	14·68	10·69	7·47	10·40	2·78
Lead	2·54	3·51	8·16	11·21	13·82

From these analyses it will be observed that in the graphic tellurium the amount of silver varies but very little, and that the analyses of Petz give exactly, what Berzelius, and a trifle more, than what Klaproth had already found. On the contrary the analyses of the weisstellur and gelberz show the greatest possible variation in all their constituents. Including Klaproth's analysis, the antimony varies from *none* to 8·54 p. c., the silver from 2·78 to 14·68 p. c., and the lead from 2·54 to 19·50 p. c.

The most rational conclusion under these circumstances is to consider these minerals mechanical mixtures of different species, such as native antimony, altaite and hessite, with a peculiar tellurid of gold.

Starting from this supposition, I found, after deducting the admixtures, the ratio of gold and the remaining tellurium as follows:

In	I,	=	1 : 4·95
"	II,	"	1 : 4·24
"	III,	"	1 : 4·78
"	IV,	"	1 : 3·82
"	V,	"	1 : 4·13

The two last analyses, those of the *massive bronze yellow* mineral, seem to prove that "gelberz" is nothing else than an *impure* calaverite.

The analyses of the graphic tellurium, for which the formula $AgTe_3+AuTe_3$ has been given, correspond better with the formula $AgTe_4+AuTe_4$, especially, if the *exact* ratio between gold and silver, which has been *found*, is taken as the basis of the calculation. Ratio of Au : Ag in I=1 : 0·84, in II=1 : 0·8. The latter would give the following composition, which agrees very well with the analysis:

Au	197·0	26·47
0·8Ag	86·4	11·61
7·2Te	460·8	61·92
	744·2	100·00

The white color of the weisstellur, together with the higher percentage of tellurium show that they are intermediate varieties, in which more or less silver is present as $AgTe_4$ replacing a portion of the gold.

The relation existing between sylvanite and calaverite is similar to that between petzite and hessite.

In connection with the tellurids of the Stanislaus mine and the new localities discovered by Prof. B. Silliman, I will mention that a specimen of gold in quartz from the Grass Valley, Cal., for which I am indebted to Dr. Lewis Feuchtwanger, contains minute quantities of a lead colored mineral, which contains tellurium, silver and a small quantity of lead, surrounding the gold. The quantity was too small for further examination.

f. Tetradymite.—I have examined two varieties of tetradymite, one found in placer gold at Highland, Montana Terr., by Mr. Kleinschmidt (I), and the other from the Phœnix Mine, Cabarrus Co., N. C. (II). I. The Montana mineral

occurs in scales. The largest of those which I received was about $\frac{1}{6}$ of an inch in diameter and about $\frac{1}{16}$ of an inch in thickness. Some of the scales showed the lateral planes of a six-sided prism. Color between lead and steel grey. It was partly oxydized into a substance, which proved to be a new mineral, a tellurate of bismuth, for which I propose the name "*Montanite.*"

For the analysis, both of the tetradymite and montanite, a weighed quantity of the mixed minerals was treated with dilute warm chlorhydric acid, which leaves the tetradymite unacted upon, whilst the montanite is easily dissolved by it. The specimen was found to contain:

Tetradymite	49·23
Montanite	50·77
	100.00

II. The tetradymite from the Phœnix mine, of which I never have seen more than the one specimen in my collection, occurs in very minute scales, the largest not being over $\frac{1}{32}$ of an inch in width, of a color between lead-grey and iron-black implanted and disseminated in quartz and associated with free gold and pyrites. From the analysis was deducted 86·71 p. c. of quartz and free gold.

The following results were obtained:

	I (Montana.)		II (Phœnix Mine).
Quartz,	0·78	Copper,	0·41 p. c.
Ferric oxyd,	0·90	Iron,	0·54 requires 0·61 sulphur.
Bismuth,	50·43		57·70
Tellurium,	47·90		36·28
Sulphur,	none		5·01
	100·01		99·94

The ratio between bismuth and tellurium in I. is very near =1 : 3, which places this tetradymite alongside of those from Fluvanna Co., Va., and Field's mine, Georgia.

In analysis II. is a slight admixture of pyrites. The requisite quantity of sulphur for the amount of iron found, is=0·61, leaving 4·40 p. c. of sulphur as a constituent of the tetradymite. The ratio between sulphur, tellurium and bismuth is =1 : 2·03 : 1, giving exactly the formula $BiS_3+2BiTe_3$.

Admitting with Gustav Rose that tellurium sometimes replaces bismuth, as in the native bismuth from the Sorato, the bismuthine from Riddarhyttan, and the mineral from Cumberland, England, analyzed by Rammelsberg, which contains 6·43 p. c. of sulphur, equal to 28·13 p. c. of BiS_3, showing it to be a *mixture of bismuthine and native bismuth,* the tetradymites

certainly should not be placed under native bismuth and considered as varieties of this mineral. It is far more rational to suppose that both sulphur and tellurium first satisfy their chemical affinities, if coming in contact with bismuth. If we reject Jackson's analysis, which is deficient in sulphur, and Wehrle's of the so-called "Molybdän-silver" from Deutsch-Pilsen, which shows a loss of nearly 5 p. c. and an admixture of over 2 p. c. of silver, all the other analyses prove that tetradymites form beyond doubt *two distinct* and *definite* compounds, those from Fluvanna Co., Va., and the Field's mine, Ga., like that from Montana Territory, being $BiTe_3$, whilst those from Schubkau in Hungary, Davidson Co., N. C., and the Phœnix mine, Cabarrus Co., N. C., are unquestionably $BiS_3+2BiTe_3$.

The bornite from San José, Brazil, requires reëxamination, before its true nature can be established.

g. Montanite, a new mineral, BiO_3TeO_3HO (or 2HO).—Results from the oxydation of tetradymite. I first distinguished it as a *new* mineral in the examination of the Montana tetradymite and named it after the territory. Having found it to be a new mineral and a very interesting one, on account of being the *first tellurate* observed in nature, I looked over my paper on the Davidson Co., N. C. tetradymite (this Journ. [II], xvi, 81), where I found that I stated that the oxydized portion "*evolved chlorine, when treated with chlorhydric acid and that therefore some of the tellurium was oxydized into telluric acid.*" Deeming a fuller investigation of much interest, I analyzed it and found beyond doubt, although my material was not quite pure, that the North Carolina mineral is *identical* with montanite. There was no tellurous acid present.

It is very probable that the "*yellow oxyd of bismuth*" from the Whitehall mine, Va., observed by Dr. Jackson (this Journ., [II], x, 78), is the same mineral.

Not crystallized, but some portions still retaining the scaly structure of the origial tetradymite, and being in reality pseudomorphous after it (N. C.). Earthy incrustations. Color yellowish, greenish and reddish white; luster waxy to dull. H. about 3. Brittle.

B. B. reactions of bismuth and tellurium. Yields water, when heated in a tube. Gives off chlorine, when heated with strong chlorhydric acid, dissolves easily in dilute chlorhydric acid. Sulphydric acid precipitates from this solution only bismuth, lead and copper, but *no* tellurium, after neutralizing the filtrate by ammonia and the addition of a sufficient quantity of sulphid of ammonium, the whole quantity of tellurium can be precipitated by dilute chlorhydric or sulphuric acid as black tersulphid. The analysis gave:

	I. From Montana.	O.	II. From Davidson Co., N. C.	O.	III.	O.
Ferric oxyd,	0·56	----	1·26	----	0·32	----
Plumbic "	0·39	----	----	----	----	----
Cupric "	----	----	1·04	----	1·08	----
Bismuthic oxyd,	66·78	6·85	68·78	6·92	71·90	7·37
Telluric acid.	26·83	7·30	25·45	7·05	23·90	6·51
Water,*	5·94		3·47		2·80	
	100·00		100·00		100·00	

The oxygen ratio between teroxyd of bismuth and telluric acid is very near equal to 1 : 1. Some doubt remains, however, to the amount of water, and future investigations have to ascertain whether it contains one or two equivalents. The composition of the pure mineral would be either of the following:

		BiO_3, TeO_3+HO			BiO_3, TeO_3+2HO
BiO_3	234	70·69	BiO_3	234	68·82
TeO_3	88	26·60	TeO_3	88	25·88
HO	9	2·71	2HO	18	5·30
	331	100·00		340	100·00

3. *Barnhardtite* from Arizona.—I have observed this mineral amongst the copper ores of Bill Williams Fork, Arizona, associated with metallic copper, cuprite, copper glance, chalcopyrite, pyrites, chrysocolla, malachite and brochantite.

An analysis made by Mr. N. S. Higgins gave:

Copper	50·41 p. c.
Iron	20·44
Sulphur	28·96
	99·81

It showed a slight admixture of copperglance.

4. *Cosalite, a new mineral*, $2PbS+BiS_3$.—A small specimen of this very interesting mineral was presented to me by Dr. Theo. L. Moss, who obtained it from a silver mine at Cosala, Province of Sinaloa, Mexico. It occurs disseminated through the whole mass of a pure, white quartz. Only *one* fragment showed a very indistinct crystalline, apparently rhombic form, slender and longitudinally striated. Fracture uneven. Luster metallic. Color lead-gray, soft, brittle. B.B. gives the reactions of sulphur, lead and bismuth, and with soda yields a minute globule of silver.

The only other mineral besides quartz, which I have observed with the cosalite was cobaltine, as ascertained by an arsenic and cobalt-determination of a small fragment. In the analysis

the requisite amount of arsenic was therefore calculated for the cobalt found, and after deducting in analysis I, 2·09 p. c. of quartz and in II, 26·83 p. c., the following results were obtained:

	I.	II.
Lead	37·72	33·99
Silver	2·48	2·81
Bismuth	39·06	37.48
Cobalt	2·41	4·22
Arsenic	3·07	5·37
Sulphur	15·59	15·64
	100·33	99·51

The analysis I shows an admixture of 6·79 p. c. of cobaltine, and II of 11·88 p. c. Deducting these quantities the composition is:

	I.	II.
Lead	40·32	38·79
Silver	2·65	3·21
Bismuth	41·76	42·77
Sulphur	15·27	15·23
	100·00	100·00

corresponding closely with the formula $2Pb\,(Ag)\,S + BiS_3$, giving the following per centage:

2Pb	207	41·65
Bi	210	42·25
5S	80	16·10
	497	100·00

Cosalite is a Jamesonite, in which the tersulphid of antimony is substituted by tersulphid of bismuth, a small quantity of silver replacing lead.

5. *Boulangerite* from Nevada.—This mineral occurs in the Echo District, Union Co., Nevada, in indistinct long acicular crystals in white quartz. One of the crystals showed prismatic planes similar to those of aragonite. Longitudinally striated. The analysis gave:

Lead	54·82
Silver	trace
Iron	0·42
Antimony	26·85
Sulphur	17·91
	100·00

6. *Tetrahedrite* from Arizona.—An analysis of a "fahlerz"-like mineral from the Goodwin mine near Prescott, Arizona,

which I have made, gave, after deducting 4·22 p. c. of quartz, the following result:

Copper,	38·16	requires S for	Cu_2S	9·63		
Silver,	3·21	" "	AgS	0·48	13·78	=1·31
Zinc,	6·23	" "	ZnS	3·07		
Iron,	1·05	" "	FeS	0·60		
Arsenic,	trace					
Antimony,	24·67	" "	SbS_3	9·84		=1
Sulphur,	26·97	" "				
	100·29			23·62		

The material for analysis appeared to be free from other impurities than quartz, and it is difficult to account for the large excess (3·35 p. c.) of sulphur. The other constituents agree very well with the tetrahedrite formula $4RS+SbS_3$.

Want of material prevented a reëxamination.

7. *Brochantite* from Arizona.—This mineral occurs in minute crystals, on which I could observe the planes *I*, $i\breve{i}$ and $1\breve{i}$, of a beautiful emerald green color, also in foliated masses at Bill Williams' Fork, Arizona. I analyzed a foliated piece, which, however, was somewhat mixed with chrysocolla and cuprite, and found:

	I.	II.
Water	14·46	----
Chlorine	0·31	0·33
Ferric oxyd	0·33	0·52
Cupric "	67·75	67·69
Sulphuric acid	13·55	13·27
Silicic "	3·60	3·59
	100·00	

This would give:

Brochantite,	$CuO,SO_3+3CuOHO$	76·49 p. c.
Atacamite,	$CuCl+3CuOHO+3HO$	2·10
Chrysocolla, (?)	CuO,SiO_2+4HO	12·68
Limonite,	$2Fe_2O_3+3HO$	0·38
Cuprite,	Cu_2O	7·96
Water,		0·47
		100·08

This is of course to be considered only as an approximation to the composition of this mixture. A more correct calculation could only be made after the composition of the atacamite and chrysocolla from Bill Williams' Fork had been established.

Philadelphia, March 1st, 1868.

ART. XXXIV.—*Remarks on the Geological Formations along the Eastern margins of the Rocky Mountains ;** by F. V. HAYDEN.

ON several former occasions I have described the different geological periods represented by the rocks uplifted along the margins of the Rocky Mountains and especially along the eastern slope. Examinations over a great extent of country in considerable detail, from latitude 49° south nearly to the Arkansas river, have shown me that quite marked lithological and paleontological changes occur in them all as we proceed from the north, southward. It is the purpose of this article to note this fact somewhat more in detail than hitherto. Beginning with the nucleus of the Rocky mountains at any point along the eastern range, we find it composed of massive granite rocks mostly red feldspathic, but not unfrequently gray or other shades of color ; then a series of metamorphic rocks (as they are usually called, though no doubt all the granites should be included with them), syenites, diorites, clay, mica and hornblende slates, and igneous rocks of various kinds here and there.

Proceeding outward we find the Silurian period represented by the Potsdam sandstone, Devonian wanting, then Carboniferous, Red beds (Triassic ?), Jurassic, Cretaceous and Tertiary, all connected together in the regular order of sequence, and all but the most recent Tertiary in strict conformity. The Tertiary deposits do not exhibit any marked change either in their mineral or fossil contents from the northern portion of our domain to the Arkansas, but the Cretaceous beds present several quite marked changes. Nos.† 5 and 4 maintain their peculiar characters as shown on the Upper Missouri, wherever they are exposed all along the eastern slope, except that they contain comparatively few fossils, yet a few characteristic species are found wherever these beds are seen, which identify them. On the Missouri river, No. 3 attains a great thickness, 400 to 600 feet, presenting massive escarpments of yellow chalk, and it can be traced all the way across the prairie country lying between 98° and 100° longitude. At Forts Hayes and Wallace on the U. P. R. W. E. D., there are massive beds of this chalk which is sawed into building blocks with a common saw, and in many instances it is nearly as white as our chalk of commerce and

* This article refers only to the eastern ranges of the Rocky Mountains, extending south to the Arkansas. The same remarks may or may not apply to other portions.

† The different divisions of the Cretaceous period, as shown on the Missouri river, have received geographical names, as Fort Benton group, &c., but I use the old divisions by figures for brevity.

might be used for the same purposes. The two characteristic species of fossils of this division are found everywhere, *Ostrea congesta* and *Inoceramus problematicus*. All along the slope of the mountains No. 3 still retains its chalky nature but becomes quite shaly, none of the layers ever becoming more than one or two inches in thickness. This is the case at the sources of the Missouri along the Big Horn and Wind river mountains also, from the South Pass to Pike's Peak, and on the western slope wherever this bed is exposed. Near Denver, at Marshall's coal mine, No. 3 has been changed by heat into a grayish compact limestone, quite hard and brittle in its fracture, which makes an excellent flux in smelting ores. But this change is local, for 16 miles north of this point it presents the same laminated character. It seems that No. 3 loses its massive chalky character, by which it first attracted attention on the Missouri river, in its westward extension, so that along the margins of the mountains except in one locality it cannot prove of any economical value, while between 98° and 100° longitude it becomes very useful not only for lime but also for building purposes. No. 2, like Nos. 4 and 5, retains its dark plastic clay character everywhere that it has been observed, but like the others it is not nearly as well developed in Colorado as on the Upper Missouri. Near Fort Benton it attains a thickness of 200 to 400 feet, while in Colorado it is not more than 50 to 150 feet. Between longitude 96° and 99°, No. 1 retains its deep rust-red sandy characters with dicotyledonous leaves, from the Missouri river to the Arkansas, but nowhere along the margins of the mountains from lat. 49° to Pike's Peak have I ever seen any well defined paleontological proof of its existence. Near Fort Benton are a series of Cretaceous beds containing some seams of impure lignite, and numerous species of fossils, not one of which is identical with those so abundant in Nos. 4 and 5 lower down on the Missouri. These beds have been placed provisionally in the general section as a portion of No. 1, but the region about Fort Benton needs a more careful examination before any positive conclusions can be arrived at. Around the Black Hills is a bed of massive siliceous rocks, some layers forming a pudding stone which in some localities takes the name of fortification rocks. These hold a position between No. 2 Cretaceous and the Jurassic marls. The same are seen along the margin of the Big Horn mountains, in which I observed a bed of impure lignite, an abundance of silicified wood, and some uncharacteristic Saurian bones. From the Wind River mountains to Pike's Peak, these same siliceous and pebble cemented rocks occur holding the same geological position, forming, as it were, beds of transition between the Cretaceous and

the Jurassic periods. I have carefully examined these rocks for hundreds of miles and have never yet detected any organic remains, animal or vegetable, in them.

The Jurassic beds, as revealed along the mountains, possess peculiar and marked lithological characters, so that having identified them by the fossils in one locality we can trace them over great areas. They were first shown to exist in the west in the form of a zone engirdling the Black Hills. They here attain a thickness from 200 to 300 feet at least, and from the beds in this locality alone have fossils enough been collected of such unmistakable Jurassic types as to prove their existence beyond a doubt. But these beds have also been shown, since they were first made known in the Black Hills, to be exposed along the margins of the Big Horn and Wind River mountains near Red Buttes, on North Platte and in numerous localities in the Laramie Plains, and westward to Fort Bridger; so numerous are the species now known from the west and so close are the affinities of most of them to well known Jurassic types that it is not necessary for me in this place to detail the evidence in support of that statement.

It is sufficient to remark, that the Jurassic system is quite plainly represented along the margins of the different ranges of mountains north of lat. 42°, but proceeding southward from Deer creek on the North Platte, the Jurassic beds diminish in force until near Cache la Poudre it becomes doubtful whether they are represented at all. At this point there is a thin bed, perhaps 20 to 50 feet in thickness, of greenish gray arenaceous marl overlying the red beds which seem to occupy the place of the Jurassic. This seems to thin out more and more as we proceed southward toward the Arkansas. From Deer creek 100 miles north of Fort Laramie to Denver, a distance of 400 miles, I have searched in vain for any organic remains in the rocks which appear to represent the Jurassic period of the Black Hills, Big Horn and Wind River mountains. In the Red beds or supposed Triassic, no organic remains have been found north of the Arkansas and they do not differ much lithologically in their southward extension except that they seem to be much thicker and more gypsiferous northward. In the far north the Carboniferous rocks are in many localities 500 to 1500 feet in thickness, and even as far south as the Red Buttes the massive beds of limestone with true Carboniferous fossils are exposed 500 to 1000 feet thick and are quite distinct from the red or varigated beds. But as we proceed southward from this point the Carboniferous limestones seem to lose their usual lithological characters and the red beds prevail. At the head of Pole creek on the eastern margin and in the Laramie Plains west, the Carbonifer-

ous rocks are mostly of a red arenaceous character, with a few layers 2 to 10 feet in thickness of whitish or yellowish limestone. From these limestones I collected *Productus Prattenianus*, *Athyris subtilita* and other well known Carboniferous forms. Above these red beds which contain intercalated layers of limestone is a considerable thickness of purely red arenaceous beds, but in studying all these rocks with some care from Pole creek nearly to Pike's Peak, I could not separate the red beds from the Carboniferous by any break in continuity, and I was rather inclined to the opinion that inasmuch as a large portion of the gypsiferous or variegated beds could be shown to be Carboniferous, they might possibly all be included in that period. The Potsdam sandstone, the only portion of the Silurian era ever detected along the eastern slope of the Rocky mountains north of the Arkansas, seems to fade out entirely south of the Red Buttes on the North Platte. It is well defined around the Black Hills, Big Horn and Wind River mountains. Near the Red Buttes there is a bed of siliceous pudding stone resting on the metamorphic rocks which may be the Potsdam in its southern extension, but south of Fort Laramie to Pike's Peak, it is somewhat doubtful whether any trace of it exists. If it occurs at all it is a very thin layer, for the most part concealed. So far as I could determine, the Carboniferous rocks rest directly (though not conforming) upon the metamorphic rocks. There is also some change in the nuclei of the mountain ranges southward. At the north the feldspathic and the gray granites prevail but southward the syenites and igneous rocks form the central portions of the mountains almost entirely. It is rare to see true granite.

The above remarks, founded on observations that have been made over a very great extent of country through a period of many years, lead me to the following conclusions. 1st. That all the formations of the west undergo more or less change both in their mineral and fossil contents in their extension toward the west and south. They all seem to reach their culmination not far from the central portion of the great area drained by the Missouri, and lose to a great extent their distinctive characters beyond its limits.

2nd. The Potsdam sandstone and the Jurassic beds present more remarkable changes than any of the others. While north both these formations are well marked, both lithologically and paleontologically; in their southward extension they gradually fade out so that south of Fort Laramie to Pike's Peak, it becomes a matter of doubt whether they exist at all. The inference therefore is that these groups of rocks are not well defined, if they occur at all south of the Arkansas. In support of this statement is the fact that although this southern region

has been traversed in every direction by multitudes of explorers for thirty years past, among whom have been geologists of high reputation, yet south of lat. 40° not a single animal fossil has ever been detected with Jurassic affinities, and it is quite doubtful whether any have been found with Triassic or Permian relations,* even the few plants that have been found are doubtful in their affinities and are regarded as probably Cretaceous or Permian. I have made these remarks from the fact that all the observations that have been made by explorers in the west during the past will, ere many years, be put to the rigid test of a most careful scrutiny, and an error by whomsoever made, though sustained by the highest authority in the land, will fall to the ground before the light of true science as the dead bark from a tree. The ease with which the Rocky mountain region can soon be reached in a few years, when our great national highways are completed to the Pacific, will induce the best geologists in this country and in Europe to visit them, and the many intricate problems of Rocky mountain geology must be solved.

The great School of Mines which will no doubt be soon established in the heart of the mining districts of the Rocky mountains, must gather around it able men who will either sustain or reject the observations of other investigators who have examined the country under less favorable auspices.

Art. XXXV.—*Remarks on the possibility of a workable bed of Coal in Nebraska;*† by F. V. Hayden.

Supplementary to my article on the lignites of the West, in the March No. of this Journal, I wish to make a few remarks in regard to the existence of workable beds of coal in Nebraska. During the geological survey last season, the greatest interest was felt in this question, by the people, from the fact that nearly all the State is a treeless prairie. Even a bed of coal, of moderate thickness, at a reasonable depth, would be of inestimable value, and the solution of this

* I do not wish to be understood as saying that the Jurassic rocks do not occur, south of the Arkansas, as well as the Permian and Triassic, for there is ample room for their fullest development, but no evidence has ever yet been obtained of its (Jurassic) existence, although the country has been so long traversed by explorers. The evidence, so far as it goes, would seem to be against its occurrence at all.

† In the final report of the U. S. Geological Survey of Nebraska, Mr. Meek has discussed the relations of the Carboniferous rocks of Nebraska, with those of the neighboring States, with great minuteness and care. He has, also, made a most extensive comparison of the fossils, from the large amount of material in his possession. He gives in his report numerous tables of fossils, in which he shows clearly what rocks may be regarded as upper Coal-measures, Permo-carboniferous and Permian, with the vertical as well as geographical range of the fossils. He finds no traces of the Dyas or Mountain limestone.

problem seemed to be the most important one of the survey. It is now known that all the Carboniferous rocks of Nebraska belong to the upper Coal-measures, and that these rocks occupy but a small area in the southeastern portion.

In ascending the Missouri, they pass beneath the water level of the river near DeSoto, about 30 miles above Omaha. The area occupied by them widens southward; but it forms only a narrow strip, hardly two counties wide, even at the south boundary of the State. Overlying the upper Coal-measure rocks, are a series of beds which were called, by Mr. Meek and the writer, Permo-carboniferous, as they occurred in Kansas, a portion of the coal-measure fossils passing up through them, and Permian types passing down. Still holding a higher position, especially in valleys of the Big and Little Blue rivers, are some beds of yellow, soft magnesian limestone which seem to be only a northern extension of what we have regarded as Permian in Kansas. Overlying these are the Cretaceous rocks—especially No. 1 or the Dakota group. There, is, however, no break in the order of sequence of the beds from the Coal-measures to the summit of the Permian.

It is now pretty well proven that in the upper Coal-measures of the West, there are no workable beds of coal, and that, while thin seams occur in many places, they never attain a thickness of more than 2 or 2½ feet. Near Nebraska City, on the Missouri, an outcropping, about 8 inches thick, has attracted some attention. This seam has been wrought by drifting in a distance of 300 yards or more, and several thousand bushels of pretty good coal have been taken from it. At Brownsville, there is a seam of coal probably holding a lower position than the one at Nebraska City, which is accompanied by several species of coal-plants peculiar to the upper Coal-measures, among which Prof. Lesquereux has detected *Neuropteris Loschi*, *N. hirsuta* and *Calamites*.

The seam of coal is from 4 to 6 inches in thickness; but the whole bed of black shale and coal is about 12 inches thick. At Aspinwall, in Nemaha county, two seams of coal were met with. One of them high up in the hills, is probably the same as that just mentioned as occurring at Brownsville, while near the water's edge another seam is disclosed about 22 inches in thickness. Coal commands a ready sale here at 40 to 80 cents per bushel. Some English miners have commenced sinking a shaft, and already cut through the 6 inch seam, expecting in due time to strike the more profitable 22 inch seam.

At Rulo, some 15 or 20 miles below Aspinwall, near the south line of the State, a seam of coal has been wrought for some years. It was about 5 inches thick at the outcrop, but

after a drift had been carried into the bank 100 feet or more, it increased to 11 inches, and then nearly disappeared again. About 200 bushels of rather inferior coal have been taken out of this mine; but it does not promise well. On the Iowa Indian reservation, this same bed has been worked, and several hundred bushels of coal taken out, but the mine was soon abandoned.

The seam on the reservation and the one at Rulo is probably id ntical with the 22 inch seam, revealed 16 feet above the water level of the Missouri river, at Aspinwall. Underneath the coal seam, at Rulo and on the Iowa reserve, is a bed of light gray fire clay, filled with fragments of plants as fern leaves, stems of rushes, Calamites; and among the ferns are *Neuropteris Loschi* Brongt. and *N. hirsuta* Lesq., both common in the upper Coal-measures of Ohio and Kentucky, and the former occurring in the Permian of Europe. Again in Pawnee Co., about 35 miles west of the Missouri, on some of the small branches of the Nemaha river a coal seam crops out which has created some excitement among the settlers.

Again at Tecumseh the county seat of Johnson Co., a thin seam of coal has been opened by a drift and worked with some success. The coal is mostly used by blacksmiths in the vicinity, for there is not sufficient to supply the country with fuel. It is probably the same bed observed south in Pawnee Co., though here the coal seems to be more impure, being made up largely of masses of sulphuret of iron.

I will here quote a paragraph from my preliminary field report of the progress of the Geological Survey of Nebraska, addressed to the Hon. J. S. Wilson, Commissioner General Land Office and printed in his annual report for 1867–8.*

"At Tecumseh a thin seam of coal has been opened, and is now worked with some success by Mr. Beaty. The drift is very similar to that before described in my report of Pawnee Co., and extends into the bank about 100 yards. Mr. Beaty has taken out about 1,000 bushels of coal, which he sells readily at the mine for 25 cents per bushel. It is undoubtedly the same bed that is opened on Turner's branch and at Friez's Mill, in Pawnee county; but is not quite as thick or as good; it contains large masses of the sulphuret of iron and other impurities. The coal seam here varies in thickness from ten to fifteen inches. The cap rock is a bed of limestone not more than two or three feet in thickness. A well was sunk in the village of Tecumseh, sixty feet. A drill was driven down through rock and hard clay a few feet further, and passed

* See report of Hon. J. S. Wilson, Commissioner of the General Land Office, 1867, pages 124–177.

through what the workmen thought to be three feet of good coal. This discovery created much excitement at the time and increased the demand for the public lands in Johnson county. It afterward turned out to be the same seam of coal worked by Mr. Beaty on the Nemaha and was only 11 inches in thickness. The prospects, therefore, for workable beds of coal in Johnson county are no better than in the neighboring counties, already examined. The evidence against any important bed of coal being found within the *limits* of Nebraska diminishes in force continually. I have already presented a portion of the evidence in former reports. The fact that all efforts in searching for coal in neighboring districts have resulted in failures, renders the prospect very doubtful."

All the rocks at St. Joseph, Missouri, Leavenworth and Atchison, Kansas, hold a lower position geologically, yet borings have been made about 300 to 500 feet at Atchison and St. Joseph, and a shaft has been sunk about the same depth at Leavenworth, resulting in the discovery of a bed of very impure coal three feet thick, quite unfit for use. The evidence is quite strong that, as I have before suggested, Nebraska is unfortunately located on the western rim of the western coal basin, and that no workable bed will ever be found in the state at a reasonable depth.

I have thus mentioned the different outcroppings of coal in various portions of the state, because their existence seemed to the people to promise better things. The consequence has been that much more money has been spent in the useless search for coal in Nebraska, than the cost of a geological survey for years.

Many excavations and numerous borings have been undertaken without success.

In aid of the solution of the problem whether there are within the limits of the state of Nebraska any workable beds of coal within accessible distance of the surface, the following conclusions are the result of the examination of these rocks during the past season. It has been accurately determined that rocks of the Carboniferous period occupy only a small portion of South Eastern Nebraska, and that these rocks are of the age of the upper Coal-measures, Permo-Carboniferous and Permian.* At Omaha, a boring of nearly 400 feet in depth was made by the U. P. R. R. without passing any important seam of coal. At Nebraska City a boring was made nearly the same distance with the same result.

* The true Permian may not occur in Nebraska. If it does, it is found only in isolated areas.

At Atchison and Leavenworth, Kansas, and at St. Joseph, Mo., where the upper Coal-measures are several hundred feet lower than at Nebraska City or Omaha, borings were made about 400 feet with no better success.

Mr. Brodhead, a geologist attached to the Missouri State Geological Survey, studied with a great deal of care a series of beds of the upper Coal-measures in northern Missouri which he regarded as 2000 feet in thickness without finding a seam of coal more than 2 or 2½ feet in thickness.

In the valley of the Desmoines river, Iowa, 75 to 100 miles east of the Missouri river, coal beds have been found by Dr. White, State Geologist, varying from 1 to 7 feet in thickness; but the rocks including these beds are regarded by him as the age of the lower Coal-measures. Indeed the upper Coal-measures of the west are regarded as the barren coal-measures, while all the workable beds of coal are confined to the lower Coal-measures. It is plain that all the Carboniferous rocks of Nebraska pass beneath the more recent formations westward to be disclosed again by the uplifting of the Rocky Mountain ranges. We find the Carboniferous limestone all along the margins of the Rocky mountains on either side the axis of elevation. On studying these fossils we find that so many of them are identical with species found in what we know to be the upper Coal-measures along the Missouri, that we do not hesitate to pronounce them as of the same age. Indeed they are simply the western extension of them, thinning out and gradually losing all the thin seams of coal and shale and nearly all the beds of clay and loose sands, leaving for the most part massive beds of limestone.

It is impossible in an article of this kind to present all the details upon which our conclusions are based; but it seems more than probable that coal in paying quantities will never be found within the limits of the state of Nebraska. If this statement is true, it is a very important negative truth not only to Nebraska, but also to very large portions of Iowa, Missouri and Kansas. We already know that the Carboniferous rocks do not exist in Dakota territory at all, so that along the Missouri river there is a very large district of wonderful fertility, almost treeless and destitute of mineral fuel. This fact at once directs our attention to the lignite formations in the region of the Rocky mountains. It is to be hoped that the general government will see the importance of making appropriations for their careful examination at an early day.

ART. XXXVI.—*Character of the Unconformability of the Iowa Coal-measures upon the Older Rocks;* by C. A. WHITE, M.D.*

THE paleozoic rocks of Iowa, with the exception of those of one period, all rest conformably upon each other, and show a regular recession to the southwestward in the direction of their general dip, the trend of their outcrops being quite uniformly in a southeasterly and northwesterly direction. The exceptional unconformability referred to is that of the lower Coal-measures upon the Subcarboniferous rocks, and in connection with the same, the unconformability of some of the members of the Subcarboniferous group upon the others. Succeeding this unconformability, the sub-epochal divisions of the coal measures again show the same gradual recession to the southwestward, together with a similar general direction of trend that the older rocks do.

Thus in the Iowa coal field, we always find the lower Coal-measures at the border; next in order comes the middle when that discrimination has been made,† and then the upper, still farther within the field.

For the purpose of being more clearly understood, the following names and numbers are given in the ascending order, of the numbers of the Subcarboniferous period as at present understood by the writer to be developed in the Mississippi valley.

V. CHESTER LIMESTONE,‡ with its sandstones above and *below*. (Kaskaskia limestone of Prof. Hall.)

IV. St. Louis Limestone. (Concretionary limestone of Dr. Owen, and in part Warsaw limestone of Prof. Hall.)

III. Keokuk Limestone.

II. Lower and Upper Burlington Limestone.

I. Kinderhook beds of Meek and Worthen. (Referred to Chemung group by Hall and others.)

No rocks referable to the Chester limestone epoch have yet been found in Iowa, and wherever the base of the lower Coal-

* In advance of his final report upon the Geology of Iowa.

† Since the writer's communication to this Journal, published July, 1867, the results of further investigations by Mr. St. John and himself in the Iowa coal field during the progress of the State work, seem to warrant the separation of those rocks, which were therein all referred to the lower Coal-measures, into middle and lower, at least in a sub-epochal sense.

‡ Judging from examinations made in Missouri, Kentucky and Southern Illinois, it is not thought that the Ferruginous sandstone of Prof. Hall is properly separable from the epoch of the Chester limestone, but believed that it should be considered as belonging to it, as those similar sandstones do which subdivide that limestone in Kentucky and elsewhere.

measures is to be observed in that state, they are *usually* found resting, apparently quite conformably, upon the St. Louis limestone. The four first members of the Subcarboniferous period are all well developed in Iowa, particularly in the southeastern part of the state. The Keokuk limestone, however, although in full force in the vicinity of Keokuk, has not been recognized to the northward of the north line of Des Moines county; and the Burlington limestone, although it has astonished the world with the richness of its fauna, loses its distinctive characters within fifty miles to the northward of the city for which it was named, yet the characters of its lower portion appear to remain in connection with the upper part of the Kinderhook beds as far north as Marshall county.

It will be seen then that these two members occupy a very limited area within the State, but the St. Louis limestone and Kinderhook beds—the upper and lower members of the group in Iowa—occupy a much larger area than any of the others.

If you draw a line on the map of Iowa, from the southeast corner of Van Buren county, sweeping a little eastward, to the northeast corner of Jefferson county, thence, keeping six or eight miles to the northward of North Skunk river to a point on the south line of Marshall county near its southwest corner, thence to a point two or three miles northeast of Eldora in Hardin county, thence to Webster City in Hamilton county, thence to Fort Dodge in Webster county, you will have approximately the eastern and northern borders of the Iowa coal field, being the thinning-out edge of the lower Coal-measures. Beyond this line, and resting upon both subcarboniferous and Devonian rocks, numerous small outliers of lower coal-measure strata exist. One of considerable extent is found resting upon the Devonian rocks, and reaching from Muscatine nearly to Davenport.

Almost all the coal of Iowa is found in the lower and middle Coal-measures; much the greater part, in the lower. The region occupied by these two divisions on the west and south of the Des Moines river is about equal in area with that occupied by the lower alone upon the east and north side. Thus that river passes through the productive coal field of Iowa as now determined, near its center. In the lower half of this area, particularly along the Des Moines and Skunk rivers and their branches, the valleys are often found to have been eroded through the Coal-measures, exposing the Subcarboniferous limestone, which in this region is invariably the St. Louis division. But that prominent angle of the coal field in Marshall and Hardin counties is found to rest directly upon the equivalent of the Kinderhook beds, the St. Louis limestone and all other

members being absent. Leaving the Iowa, and going westward to the Boone and Des Moines rivers along the northern border of the coal field, we find at Webster City in Hamilton county, and at Fort Dodge in Webster county, the Coal-measures resting again immediately upon the St. Louis limestone, while the equivalents of the Kinderhook beds are found coming up to the surface northward of those localities in Pocahontas, Humboldt and Franklin counties. Thus it will be seen that if we except the absence of all the rocks of the Chester limestone epoch, the only real unconformability of the Coal-measures, so far as we now know, consists of the overlapping of the northeastern corner of the coal field from the St. Louis limestone upon the Kinderhook rocks. We also see that there is still greater unconformability among the members of the Subcarboniferous period themselves.

The characters, both paleontological and lithological, of the St. Louis limestone, remain almost unchanged from the northern to the southern limits of its extension in the State, a distance of two hundred miles. The trend of its eastern and northern border evidently does not partake of the angle which the outline of the coal field forms in Hardin and Marshall counties, but conforms more nearly with the older formations in that respect.

The characters of the Kinderhook beds are more changed as they extend to the northward from their typical localities, yet they may be readily identified, both by lithological and paleontological characters. The beds become more calcareous to the northward, and in the counties of Franklin, Humboldt and Pocahontas they consist entirely of limestone ; yet the peculiar fine-grained, yellowish sandstone so characteristic at Burlington is found as far north as Tama county. At this point there is a fifteen foot bed of fine oolitic limestone resting upon it, which is referred almost without hesitation to the oolitic member as seen at Burlington. The limestone of its most northern extension is also principally oolitic.

In view of the foregoing facts the following conclusions are offered.

From the time of the Potsdam period to the close of the Kinderhook epoch of the Subcarboniferous period, there seems to have been a regular and gradual recession of the sea to the southwestward. At the close of that epoch, or in the early part of the Burlington limestone epoch, there was a very marked recedence of the sea, so that the characteristic limestones of that epoch did not reach farther north than the southern part of Johnson county. This recedence then continued gradual until the close of the Keokuk limestone epoch, at which time

the St. Louis limestone sea re-occupied nearly the whole area formerly occupied by that in which the Kinderhook beds were deposited. At the close of the St. Louis limestone epoch there was so extensive a recedence of the sea that the Chester limestone did not probably reach within two hundred miles of the southern limit of Iowa. At the close of this last Subcarboniferous epoch there was another remarkable re-occupancy of shallow seas, so that the Coal-measures received their first deposits, not only upon the surface of the St. Louis limestone, but also overlapped upon the Kinderhook rocks, and doubtless others besides; for we have no assurance that the outliers before referred to were not at one time connected parts of the great coal formation.

Iowa State University, March 2d, 1868.

ART. XXXVII.—*Remarks on the Sedimentary Formations of New South Wales, illustrated by references to other Provinces of Australasia;* by the Rev. W. B. CLARKE, M.A., F.G.S., F.R.G.S., etc.*

IF we inspect the map of Australia, we observe that the coasts of Victoria, New South Wales and Queensland, follow the general directions (with some irregularity) of the Cordillera, or elevated land separating the waters flowing directly to the coast from those which, draining the interior, disembogue to the S. W.

The Murray river receives some part of its tributaries from the highlands of Victoria, and others from New South Wales; whilst the Darling and its tributaries collect the remainder of the supply, from as far north as 25° S.

The Cordillera thus sweeps round in an irregular curve from W. to E. to the head of the Murray—and thence, northerly and northeasterly, to the head of the Condamine; trending northwesterly from that point to 21° S., whence it strikes to the north, terminating its course at Cape Melville, in 14° S., about the meridian of 144° 30′, which is that of Mount Alexander in Victoria.

The more westerly and southerly trend of drainage is represented by the Thomson and Barcoo rivers, which carry off the waters of the Cordillera at the back of the Barrier Ranges to Spencer's Gulf. The meridian of the head of that gulf is, therefore, the western limit of East Australia.

The Cordillera itself, described by Strzelecki in 1845, was traced by him through a considerable part of its diversified course

* From a pamphlet received from the author.

(as understood by him), from the southern point of Tasmania to the parallel of 28°, in longitude 152°; but not further westward than 146° on the parallel of Mount Alexander. It is, however, doubtful whether the ranges between this furthest western point and Wilson's Promontory, where he considers the Chain to be cut off by the sea, is anything more than a spur in that direction.

But the extent of the Cordillera westerly, to its termination on the border of South Australia is so well defined, that there can be no question that the S. W. and W. extension has as true a character as any part of the Northern prolongation. This may be geologically deduced from researches of the Geological Survey of Victoria. That province is limited, at its eastern corner, by a line joining Cape Howe and the head of the Murray, so that the boundary crosses very near the highest point of all Australia, which Strzelecki made 6,500 feet above the sea, but which subsequent observations have shown to be 7,175 feet. This correction rests on observations made by myself, in 1852, and a re-discussion of them, in comparison with results obtained by Professor Neumayer in 1862. On 8th May, 1852, I made the highest point of Kosciusco, 4,077 feet above my then base, at 3,098 feet above the sea, which therefore came out 7,175 feet; and in February, 1863, Professor Neumayer wrote me word that he made the highest peak in November, 1862, 7,175 feet. This makes Kosciusco's summit above the crossing place of the Indi or Hume river, at Groggan's, 5,425 feet.

The 144th meridian to the northward limits very nearly all the high land of the East Coast to Cape Melville, whilst the 142nd meridian limits to the westward the basin of the Darling, including part of the drainage along the Thomson and Barcoo from the head of the Flinders, to where it passes into South Australia, on the 141st meridian.

Thus, all this enormous drainage of western New South Wales and southwestern Queensland is, as it were, bounded by ranges of high geological antiquity, the Grey and Barrier groups being of undoubted similar age to the mass of the Eastern Cordillera.

It has long been known that the strike of the older sedimentary rocks all through the Cordillera, in Victoria, as well as in New South Wales, it is generally meridional; so that in the former province the beds strike across the Cordillera, whilst in the latter they form various angles from parallelism with it to a transverse direction, as the Chain doubles and winds irregularly in its course.

This is the experience of the Victoria Survey, and my own traverses across various points of the Cordillera in New South

Wales and Victoria, establish the fact of a normal meridional strike of the older strata. So distinct, indeed, is this characteristic, that the settlers in various parts of the country have been accustomed to trace the direction of north and south by the strike of the slates.

It sometimes happens that, owing to the high angle of dip, and the effect of denudation on the overlying formations, the Cordillera itself becomes in places almost knife-edge, so that in New South Wales it presents occasionally a *divisa aquarum* not more than nine paces in width; whilst in Maneero to the south, and New England to the north, it spreads out in a plateau, on which eastern and western waters rise close together, and sometimes overlap. These different features have a variable geological aspect as well as value; for owing to the strike of the older rocks, the breadth of the Silurian formations, which, as in other countries, are repeated by recurring folds, may be more exposed in Victoria than they are in New South Wales; and owing to the curve of the Cordillera, probably the same beds are traceable to the north which occur in the south; as, for example, the auriferous rocks of Omeo and Peak Downs, which are on the same meridian; and thus the meridional strike is exhibited along the northeast coast, where there are alternations of old rocks forming precipitous cliffs, with low valleys and beaches separating those alternations.

Independently of this arrangement, the whole of the Central area inside the Eastern Cordillera has a trend to the south and west, so that the waters collected between 22° and 37° S., on the east of South Australia, find their way to the sea at the eastern corner of that province.

We might naturally assume that the same order of deposits is to be expected throughout the Cordillera; but there is a singular exception. Whilst marine deposits of Tertiary age are found along the coast of Western Australia, and along the southern coast from Cape Leuwin to Cape Howe, there are no known *marine* Tertiaries in any part of the coast of New South Wales and Queensland up to the Cape York Peninsula; and the reason of this may be, that, as indicated by phenomena before pointed out by me, but which on this occasion cannot be further dwelt upon, the eastern extension of Australia has been cut off perhaps by a general sinking (which is in accordance with the Barrier Reef theory of Mr. Darwin), and which has some support from the fact that there is repetition of Australian formations in the Louisiade Archipelago, New Caledonia, and New Zealand, in the latter of which occur abundant tertiary deposits, in which case the intervening ocean may be supposed to cover either a great synclinal depression or a denuded series of folds.

Relatively speaking, therefore, the Cordillera of the Eastern Coast has not been subject to the changes which introduced the relics of a Tertiary ocean. At any rate, no evidence is known to me of *marine* Tertiaries on the lands north of Cape Howe.

Another fact worthy of notice, as showing the probable ancient geological vicissitudes of Australia is, that the great Carboniferous series which is so prominent in New South Wales and in parts of Queensland, but which is less distributed in Victoria, and there only partially and irregularly as to the portions still remaining, has been broken up and carried away, so as to have left the various members dislocated, ruined, and separated in such a way as to allow no clear view to be taken of the whole till all the separate portions have been separately examined; and to the want of this personal examination on the part of certain Paleontologists and others, who have never yet seen the Carboniferous formation of New South Wales, is to be attributed the perseverance with which they so long disputed facts as attested by geologists in New South Wales, who are familiar with the latter and with Victoria also.

In consequence of the absence of marine tertiary deposits in New South Wales, and the occurrence of a more complete series of the strata in the sections of the Carboniferous formation, there has arisen a difficulty in collating the gold deposits with those of Victoria; and, in this respect, at present the upper deposits in the former province cannot be assigned with any precision to the epochs adapted by Mr. Selwyn for the latter. And it also follows, that his view of the distinct ages of Pliocene auriferous and Miocene non-auriferous gravels cannot be tested in New South Wales; if, indeed, it has not already been tested by the actual discovery of gold in the so-called Miocene deposits themselves as they occur in Victoria.

So far as is at present known, the gold is derived chiefly from the Lower Silurian formation; but researches conducted for me at H. M. Mint in Sydney, prove that it exists in almost every distinctive rock in New South Wales. In this province the alluvial deposits are not so extensive as in Victoria; but this probably arises from the fact previously mentioned of the strike being in Victoria transverse to the direction of the Cordillera; by which means the currents which distributed the drift had a wider area of gold-bearing materials to denude than in New South Wales, where, I conclude from numerous examples, the principal currents were to northward, so that in that province they would coincide with the direction of the Cordillera, and not accumulate the deposits in such low-lying extensive regions as those of the Murray Districts. The same objection would obtain, on the supposition of gradual waste

and accumulation from less powerful agency than that of a general rush of water. It is not, however, to be doubted, that there is an enormous amount of gold yet untouched in numerous places in New South Wales, not only in the quartz lodes (or reefs), but in gullies and plains where alluvial gold diggings will yet be discovered.

The distinctive differences in material mineral wealth between Victoria and New South Wales are not altogether confined to gold, or tin, which latter metal is well represented in the New South Wales Court; but coal, iron and copper, and perhaps lead, also exhibited, prove more than an equivalent of the great amount of gold at present in Victoria.

At the Universal Exhibition of 1854 the present writer exhibited a collection of rocks and fossils, illustrating the whole of the geological formations of Australia, and these were enumerated in their stratigraphical order in the published catalogue. On this occasion, it has not been possible to complete a similar and more extended collection, owing to the effects of protracted illness; but it may be useful to introduce a few remarks on the various geological epochs as they represent themselves in New South Wales, with a brief statement as to their connection with other portions of Australasia.

Azoic and "Metamorphic" Rocks.

There has not been sufficient evidence yet collected to show that these rocks have been ascertained to exist in Eastern Australia, although in Tasmania rocks of a doubtful class (and which may, perhaps, be only highly altered Lower Silurian) have been referred to them by Mr. Gould. The existence of gneissoid strata and of slates of very ancient aspect, has also been well known in New South Wales, with occasional unfossiliferous limestones; but it would be premature to place them, without doubt, under the present head. Some of those mentioned under the First Epoch of Strzelecki have, on close inspection, appeared to the writer to be merely the products of transmutation, nor is such an improbable result, seeing that in Australia some slates have apparently been changed into granitic rocks. It is, at least, certain that such rocks, except in Tasmania, generally occur in the immediate vicinity of granites, though the latter frequently occupy large areas both in Maneero and in New England, as well as along the Cordillera, and in independent masses along the coast. In Western Australia, where an enormous region is occupied by granites, and the older formations are represented only by small patches of slates, whilst the granites themselves remain bare, these patches are found on the flanks of the granitic bosses, and at extremely wide intervals;

nor have I been able to detect, among the numerous collections which have passed through my hands, distinct evidence of any but doubtful examples of those foliated rocks which belong to the so-called Primary epoch. In Southern Australia, also, there does not appear to be any considerable amount of strata which could be referred to this epoch.

Lower Paleozoic Rocks.

Of these there are undoubted evidences in some limited districts of Tasmania, whilst in New South Wales and Queensland considerable areas are occupied by them.

The greater mass of them, in the two latter provinces, appears to belong to Upper and Middle Silurian; the mudstones of Yarralumla, with Encrinurus and Calymene; the Coralline and Pentamerus beds of Deleget and Colalamine; the Tentaculite and Halysites beds of Wellington and Cavan; and the beds with Calymene, Encrinurus, Beyrichia, and others with Illœnus, Harpes, Bronteus; Brachiopoda, including Strophodonta and Radiata embracing Star-fishes, point to the existence of at least the Upper Silurian formation on both flanks of the southern part of the Cordillera. There are also numerous corals included in the list given by me in the Southern Gold Fields (p. 285), which also confirm the same determination; and it may be added that the above, and other fossils of this age mentioned by me elsewhere, have been examined by Paleontologists of eminence in Europe. Such are the genera Favosites, Cœnites, Ptychophyllum, Calamapora, Syringopora, Emmonsia, Alveolites and Cystophyllum, &c. These, perhaps, might not alone satisfy a doubt, but with them occurs Receptaculites; since 1858, when these were determined, I have detected Halysites, which may settle the question as to Upper Silurian. Wenlock beds seem to be well developed on the Deleget.

In Victoria, numerous species of Grapolites have been found, but during my explorations of New South Wales I discovered none. It is only recently that they have been found in the most southern part of the province on the M'Loughlan river and also in other spots in the basin of the Snowy river, near the boundary of Victoria.

In Tasmania I saw fossils similar to those of New South Wales, from beds on the Gordon and Franklin rivers; but Mr. Gould has since placed them partly as Lower Silurian. Lower Silurian beds also occur on the Deleget river, where both the upper and lower have a generally meridional strike, but varying dips.

In Queensland, Mr. Daintree has confirmed the fact of the

existence there of Silurian rocks identical with those of Victoria; and my own examination of the Brisbane Slates led me to compare them with the auriferous slates of the Anderson's Creek Gold Field. The quartz veins of that neighborhood were found by me in 1851 to hold gold, and some very recent researches have increased the expectation of valuable deposits there, in addition to those which have already been opened on the Burnet, Crocodile Creek, Mount Wyatt, the Burdekin, Talgai, and Star Creek; about Peak Downs, and in other places.

The Gold Field of Fingal in Tasmania is also partly occupied by rocks of Silurian age, the lithological structure of which is identical with rocks in New South Wales and Victoria.

Copper is abundant in strata which may be referred to the same epoch; but a peculiarity which I have observed in most of the copper localities is, that the ores do not occur in lodes of the usual character, but sometimes, as on Peak Downs in Queensland, they follow the planes of the strata, and generally in New South Wales assume a dome-like form, rising in bosses at intervals without continuous surface connection. The Burra Burra Copper Mine of South Australia has also something of the same character. I have in my possession Pentamerus from Bombala, in which the shells are embedded in copper ore.

Specimens are exhibited from Bombala and Cavan, not only of Fossils, but of Copper, Lead, and Iron. (No. 475 & 474.)

Middle Paleozoic Rocks.

Mr. Jukes has shown cause why the term Devonian should be eliminated, referring the so-called beds to the bottom of the Carboniferous formation.

It is probable that such will have to be the fate of certain strata in Australia, the fossils of which have at once a Silurian and a Carboniferous aspect; being connected with the former by certain corals, and with the latter by the occurrence of Lepidodendron, Sigillaria, and other Lower Carboniferous plants.

There is undoubtedly a regular passage downward from the marine fossils of the acknowledged Lower Carboniferous beds of New South Wales, to others which very much resemble the so-called Devonian beds of England; and a series of shells, corals, &c., from the Murrumbidgee, which I submitted some years ago to Messrs. Salter & Lonsdale, through Sir R. I. Murchison, Bart.,* excited doubts as to their belonging to any but Silurian and Carboniferous deposits. Among these were Phanerotinus, Loxonema, Atrypa *reticularis*, Orthis *resupinata*,

* See Murchison's "Siluria," 3d ed. p. 296.

Murchisonia, Strophomena, and Spirifera of various species, some like Devonian. Loxonema is known to me as occurring in the lower marine beds of the Hunter river basin—certainly below the upper coal beds.

There appears to be an intermixture, and such is the case with certain strata to the westward of Wellington, in which some of the fossils have the Carboniferous type and others the Silurian. In the list before mentioned these are included in Passage beds.

In Victoria, near Mount Tambo, in Gipps Land, and again near the head of the Murray, there are some limestone beds with fossils, which I visited in 1851, and then believed to be of the same age as the lowest Carboniferous rocks of New South Wales. The Victorian geologists consider them Devonian.

In Queensland, the Burnet Range and tracts about the Bowen Gold Feld and Burdekin (in which river limestones with fossils occur), are strewn with spoils of a formation which Mr. Daintree calls Devonian. From the former locality I have had many collections, and among them all I find Productus in alliance with Trilobites which appear to be older than Carboniferous. But, if Mr. Jukes's arrangement holds good these will probably be placed in the latter formation. On the western flanks of the Cordillera, near Yass, and on the eastern, along the Shoalhaven river, and again near the Hanging Rock, New South Wales presents numerous bands of limestone full of such fossils; and it may be doubtful at present whether these lie on the horizon of the Devonian, or whether they belong to some portion of the Upper Silurian. As these beds appear to range all through the country on a nearly meridional strike, on both sides of the Cordillera, they are traceable in widely different places; and it may eventually be determined that, though in close contact, there is really a distinction of formations, only to be detected by accurate survey. So far as Lepidodendron is concerned, that plant occurs in some places in association with beds that are decidedly younger than any called Devonian, near Pallal on the Horton river, and on the Manilla river in Liverpool Plains, and in the gold drift of the Turon river, which has been derived from beds of transmuted sandstone belonging to the coal beds at the head of the river. Near Wellington, also, Lepidodendron has been found in hardened rock of similar origin. At Canoona Gold Field, in Queensland, Lepidodendron occurs in hardened shales; and at Goonoo Goonoo, on the Peel river, in New South Wales, it occurs in fine grey sandstone, with Ferns and Sigillaria in close proximity to beds of marine fossils which are certainly Lower Carboniferous.

Besides these fossiliferous evidences of supposed Devonian

age, there are beds of grit, sandstone, and conglomerate, occupying positions of extreme doubtfulness as to age, not only in Victoria, but also all along the coast ranges of New South Wales, which, as described by me, and confirmed by Mr. Daintree, are certainly older than some parts of the Carboniferous formation. They make a near approach to the "Old Red" of Europe. In my Report to the Government of New South Wales (6th March, 1852), I have mentioned that I had traced these beds "from the head of the Shoalhaven to the head of the Genoa;" and Mr. Daintree, in his Report to Mr. Selwyn, Director of the Victorian Survey (26th May, 1863), adopts my description, word for word, as applicable to "the Grampian sandstones, the conglomerates south of Mount Macedon, of the Avon river and Tambo, Gipps's Land;" and he adds, "there can be little doubt they are all members of one great formation."

At Mount Tambo, according to Mr. Selwyn (1866), they underlie the limestone of that locality, which he therefore considers as probably Carboniferous; and this, as stated above, was my view in 1851.

About Eden (Twofold Bay), and Panbula and Merrimbula, to the north, there occur a series of beds which, in 1851, I also ranked as Devonian; but, on visiting the district in 1865, I was inclined to think they might be much older. Nevertheless, they are connected with Porphyries, with double-headed hexahedral crystals of quartz, which are common in countries assumed to be of the age of "Old Red." After all, there will have to be an adjustment of this and other questions, which may hereafter distribute very differently parts of formations which at present are considered fixed.

In Western Australia, Mr. H. Gregory indicated on his map, and in his Report, the existence of Devonian rocks near York, and in other parts of that colony. Having examined the rocks so indicated, I can only state my belief that they have no pretension to any such antiquity, and are probably mere collections of loose granitic matter and other drift cemented by ferruginous paste, which has since become transmuted into concretionary nodules and hæmatite. There are also pebbles of trap, much decomposed, in the so-called Devonian.

Upper Paleozoic.

That this division of rocks is fairly represented in New South Wales there can be no dispute. It has been long determined by all Paleontologists, that the lower Carboniferous marine beds of Europe are represented by the beds immediately below the Upper coal measures of the Hunter river, of the Illawarra, Talbragar, &c.; and we know also, that fossils of the

same age occur in a part of Western Australia, near the Irwin river in Queensland; in Tasmania, and in Victoria.

Associated with them, both above and below, in New South Wales, Coal beds of various thickness (from 3 to 30 feet) occur. In the Newcastle basin alone there are at least 16 seams more than 3 feet thick, sections of which have been published by John Mackenzie and W. B. Clarke, and are exhibited. (See No. 477.) Up to a comparatively recent period, it was not known that under the marine beds below these coal seams, other seams occur bearing the same genera of plants as in the upper beds, of which Glossopteris and Phyllotheca are very abundant. When this fact was first published by me, it gave rise to controversy; but the truth of my conclusions has been confirmed since by Mr. Daintree, who, visiting and examining the spot in dispute, found four or five seams in the position to which they had been assigned. Now, below these lower coal measures there is an enormous thickness of fossiliferous strata, in which the fossils (as before stated) gradually assume what has been called a Devonian aspect. The opposition to this determination has arisen from a preconceived idea that strata bearing Glossopteris could not be Paleozoic, and therefore, that the upper coal measures of Newcastle had no right to be considered older than *Oolitic*. But whilst these upper measures produced a fish of undoubted Paleozoic character (Urosthenes *australis*), Cleithrolepis *granulatus*, Myriolepis *Clarkei*, and other Ichthyolites, examined and determined by Sir P. de M. G. Egerton, Bart., to be Paleozoic, have been found by me at least 1,000 feet higher, and of which photographs are exhibited on this occasion. (See No. 351.)

This dispute, therefore, ought long ago to have been settled; but unfortunately it was taken up out of the Colony, and found some support in the writings of DeZigno, author of "*Le Piante Fossili dell' Oolite.*" Since then he has modified his views, and, in a subsequent publication, in the "*Rivista periodica*," Padova, vol. xiii, 1863, admits that the Australian coal beds are rather *Triassic* than *Oolitic*. He still, however, does not quite comprehend the whole question.

Above the coal measures, including Urosthenes and Glossopteris, *i. e.*, in the Hawkesbury and Wianamatta beds, in which Cleithrolepis, Myriolepis and Palæoniscus occur without Glossopteris, Baron De Zigno imagines, from the way in which the evidence has been put before him, that beds with Pentacrinites, Ammonites, and Belemnites, which will be mentioned hereafter, interpolate the beds with Palæoniscus, &c. Nothing, however, of the kind has ever been found in Hawkesbury or Wianamatta beds; and the only fossils of the genera named occur in

Queensland, full 600 miles distant. Professor M'Coy having believed the coal of New South Wales to be Oolitic, and believing the Pentacrinites, &c., to be Oolitic also, and Lepidodendron having been stated to be found in beds below the coal in marine beds of assumed Devonian age, it was too hastily inferred that Professor M'Coy and myself were writing of two distinct *coal* epochs.

That the coal measures of New South Wales are, however, truly Carboniferous, has been since determined by plant evidence ; for in Queensland, where the Newcastle coal measures can be identified, a plant very near to, if not the same as, Alethopteris *lonchitica*, has been found, and there are in the present Exhibition several examples of it. (See No. 470.) Moreover, near Stroud I long ago detected a magnificent fern, in beds which belong to the Hunter river coal measures, which Sir C. Bunbury has named *Adiantites eximius*.

Whether the masses of coal exhibited look more like a Secondary than a Paleozoic coal, may be fairly left to the decision of competent judges. (See Nos. 214—233.)

Another ground on which the age of the New South Wales coal beds was disputed is, that in Victoria there are certain beds which (*me teste*) resemble some of my Wianamatta beds, and therefore, assuming them to be *Oolitic*, New South Wales was involved in that dictum also. Now, the true European coal measures (according to Mr. Selwyn), "so far as is known at present, do not exist in Victoria ;" nor has Glossopteris been found there at all. Moreover, the Survey has sunk through 4,000 feet of consecutive beds, without finding a profitable seam anywhere ; and, though the limestones of Gipps's Land are acknowledged as Lower Carboniferous or Devonian, there is not an atom of evidence to be obtained in Victoria as to the Secondary age of the New South Wales coal. Thus stands the question at this moment. If now we turn to Tasmania, we have clear evidence as to the occurrence there of true Paleozoic coal, and if we pass on to Queensland we have equally clear evidence ; and, what is more, there are sections on the Bowen river (full 1,000 miles from Sydney), in which the whole history of the coal beds may be read off without error.

Mr. Daintree writes thus :—"The Bowen river Coal series would afford more conclusive sections in the upper portion than your own ; since, besides the seams of coal lying at the base of the Bowen river series, *interstratified with beds containing a marine fauna*, which Professor M'Coy acknowledges to be *Carboniferous*, there are likewise beds *containing a nearly similar fauna, resting on beds with abundance of imbedded Glossopteris.*"

I learn also, from the examination of both Fauna and Flora, specimens of which were in my possession before Mr. Daintree had visited Queensland, that the former contains the identical species described by M'Coy (*Annals Nat. Hist.*, vol. xx), such as Productus *brachythœrus*, Pachydomus *globosus*, Allorisma *curvatum*, whilst the latter contains Phyllotheca *australis* and Glossopteris *Browniana*, and others, which were assumed to be Oolitic at Newcastle, but must be admitted to be Paleozoic on the Bowen river.

The coal seams on the Bowen river are of variable thickness, but a ten-foot seam has been noticed.

Mr. Gould, in his Report to the Government of Tasmania, Ootober, 1861, also states that the Mersey river worked coal seam belongs to the formation with the same marine fossils as in Queensland, and on the Hunter in New South Wales.

Having visited the Tasmanian locality for the purpose of inspection, I can confirm all that has been stated respecting the occurrence of the marine Paleozoic fossils, *Orthonota*, *Spirifera*, *Fenestella*, *Pachydomus*, *Theca*, &c., in association with and immediately above the coal.

So far, then, the question about the age of some of the Australian coal must be considered as settled ; and if, as in Illawarra, the coal beds overlie the marine beds, as they do also in the Fingal district of Tasmania, it would appear that all these separate occurrences belong to one thick series, in which marine beds and fresh-water beds interpolate each other. But, assuredly, in that case, the arrangement adopted must express the order as follows :—

4. Upper coal measures.
3. Upper marine beds.
2. Lower coal measures.
1. Lower marine beds.

So far as I know, the latter rest frequently on a conglomerate, which in Tasmania I found to contain undoubted Carboniferous fossils.

Since the Exhibition of 1862, on which occasion, in a paper on the Coal Fields, I noticed the occurrence of Oil-bearing Cannel Coal at the foot of Mount York, and at Colley Creek in the Liverpool Ranges (not on eastern waters), the former has been in great request for the purpose of producing illuminating oils ; and the produce has been brought into the market. In the former locality, and in Burragorang, I have made some recent researches, which have satisfied me that these can only belong to the Upper coal measures, for they bear distinct evidence in the fronds of Glossopteris, which are very clearly impressed upon the beds at Mount York ; whilst at Burrago-

rang the blocks of Cannel are found in an intermediate position, between the top of the coal measures and the upper marine beds, which, if not the overlying measures, bear the very strongest resemblance to the Hunter river series.

In Illawarra, also, there are shales which are above that geological position, and which produce oil for illumination, but are not of the peculiar character of the Cannel at Mount York, which, in a great degree, resembles the Bog Head mineral of Scotland, only it is more valuable. Specimens of all the products under the present heading will be found in the Exhibition. It has been an object of inquiry whether Petroleum springs exist in New South Wales. Such have been reported from the Corong in South Australia, and from Taranaki in New Zealand, and from Victoria. The former is, we learn, a mistake; being probably at a point where certain animal substances have decomposed. In New South Wales there are also two localities, known to me for many years, in which Petroleum exudes; and there are two or three in Western Australia, the products from which I have examined. Nothing of value has as yet been found. (See Mr. Keene's collection exhibited in London, 1862, and again exhibited, pp. 81–89.)

Secondary Rocks.

I have previously made mention of the Hawkesbury and Wianamatta beds; and a collection of them, illustrated by a catalogue, was exhibited at Melbourne. Some of these were also shown in the Universal Exhibition of 1854, and therefore have not now been repeated.

Whether they be acknowledged hereafter as Paleozoic (which the fishes determined by Sir P. M. de G. Egerton, Bart., would justify), or whether, with Mr. Selwyn, we consider them (against that evidence) to be Secondary—or whether we suppose, with him, that the beds in Victoria called by him Secondary are a portion of my Wianamatta beds—there is nothing to explain the statement made by de Zigno, in his valuable paper before the Academy of Science, in Padua, on 23rd April, 1863, in which he says:

Altri depositi pure d' incerta classificazione ci si schierano innanzi prendendo ad esaminare i terreni a combustibile fossile della Nuova Galles meridionale e della Tasmania, che il M'Coy aveva fino dal 1847, collocati nel piano dell' Oolite, mentre Clarke annunciava di avervi rinvenuto i Lepidodendri dell' epoca carbonifera.

Successivamente le nuove indagini instituite dal M'Coy lo ponevano in grado di chiarire come i resti trovati dal Clarke appartenessero a depositi collocati ad una grande distanza di quelli le cui piante accenavano ad un' epoca più recente.

* * * * *

Egli cita in questi ultimi depositi la presenza di quattro Cicadee e di una *Tæniopteris* multo affine alla *Tæniopteris vittata* dell' Oolite di Scarborough, e nota come presso Volumbilla abbia trovato Belenniti, Pentacriniti e varie conchiglie che s' approssiomano alle specie proprie dell' Oolite inferiore, del Lias e del Trias. (p. 148–9).

Now in this statement are three things to be reconsidered:—

1. It has not been said by me that the Lepidodendron, &c., were in the same beds with Glossopteris (though evidence has come out recently to the effect that these plants have been found together at Newcastle), but it has been held that the Glossopteris Coal beds and the Lepidodendron beds are part and parcel of one great formation.
2. In New South Wales no Cycadites and no Tæniopteris have been ever found, though they occur in Victoria in the beds considered by the geologists there to belong to the Wianamatta beds.
3. Neither in the Victoria beds, nor in the Wianamatta beds, has ever been found a Belemnite, a Pentacrinite, or any shell, save a fresh-water Unio in Victoria, and one shell in New South Wales from the fish-bearing shales.

There is, however, a far more important matter to be rectified.

When I first reported the discovery of Secondary fossils from Wollumbilla in Queensland, it was as *Cretaceous or Jurassic;* but Professor M'Coy described them, in September, 1861, as *Lower Secondary*, and as the marine representatives of the formation, to which belonged, in his opinion, the Victoria "carbonaceous" beds, and the coal measures of New South Wales, *i.e.*, of the age of the Scarborough Oolite. Among the Wollumbilla fossils were some which looked older than Cretaceous; and therefore, certainly guided by Prof. M'Coy's determination, I adopted his view of an older period, and even considered that some of the fossils indicated a Triassic age; (there was certainly a brachiopod which looked older than Triassic;) consenting to the possibility that the Wollumbilla beds might prove really to be of the same age as the Wianamatta beds. But I have learned two things since, first, that the fishes of the latter are Paleozoic, and secondly, that the Wollumbilla fossils on comparison and examination in Europe, whither I sent them, are by geologists there considered to be really *Cretaceous;* and as Professor M'Coy has himself published two Cretaceous species from Queensland, in 1865, and as I have collected evidence to geologically connect their localities (Flinder's River) with that of Wollumbilla (though otherwise so widely separate), there will be the less difficulty in allowing the Cretaceous epoch, first suggested by myself as applicable to

fossils in *situ*, to be acknowledged as well developed in Queensland. But we shall then see how little is its relationship with the Wianamatta, and how still less with the Victorian beds.

This reference to a very important circumstance leads me to suggest, that whether the Wianamatta series is to maintain a Paleozoic pretension or whether it is to ascend to the Trias, the arrangement which will be found most correct will probably be represented somewhat in this wise :—

4. Cretaceous. Wollumbilla, Flinders, &c., (Queensland) and Western Australia.
3. Inferior, or Great Oolite. Deposits at Wizard Peak, &c., Western Australia.
2. Trias, Victoria.
1. Paleozoic. Wianamatta, Hawkesbury, and Coal beds of New South Wales.

In which arrangement, I would place the Victorian "carbonaceous" above my Wianamatta beds. Of course, subsequent discoveries may modify such a view, and lead to a final settlement of opinion, by enabling geologists to fill up the *gaps* which undoubtedly exist ; proving, perhaps, that the Cretaceus fossils picked up in drift by Mr. Selwyn indicate the former existence of Upper Secondary rocks in that province, as the Ammonite brought to me on the Clarence River Coal Fields in 1853, may indicate the former presence there of an Oolitic formation.

That Cretaceous or Jurassic rocks formerly occupied and still occupy an enormous range in Queensland, I can now assert, having obtained some of the additional information which I proposed to collect in 1861. I have now been able to discover that rocks of the above epochs range from the east of Wollumbilla across the Maranoa and Warrego to the Nive and Barcoo ; thence along the head of the Thomson to the Flinders, and so round by Tower Hill and the Belyando back to the Amby and Maranoa Rivers ; not, of course, in one uninterrupted area, but resting on the Carboniferous and other Paleozoic formations, thus exhibiting a very extensive distribution of Secondary rocks ; and it will probably be found that various groups of the Jurassic epoch are represented there.

It is certainly singular that some well-known species of European reputation, or their representatives, are found in the Western Australia Oolite, such as the following of the Great Oolite :—Trigonia *costata;* Ostrea *Marshii;* Ammonites *Moorei;* Lima *pectiniformis;* Avicula *Munsteri*, &c.

None of these have, however, been found in Queensland, New South Wales, in Victoria, or Tasmania ; but in the latter island, there are undoubted equivalents of some part of the Wianamatta series, as well as of the Coal measures and lower Carboniferous beds of New South Wales.

In New Zealand the greater part of the Coal measures is not Paleozoic, but some of it is said to be Secondary, to which epoch also belong the Jurassic Plesiosaurus and Ammonites; and Triassic Aviculæ and Monotis.

In New Caledonia, there is also a distinct Triassic series, of which some of the fossils are akin to those of New Zealand. But, at present, neither has this nor the Belemnites of Queensland been found in New South Wales.

So far as the question of Coal is concerned, no Coal seams (but only thin patches or very limited layers) have been found in the Wianamatta or the Hawkesbury rocks, that can be compared even with the alleged Secondary deposits of Victoria; and in Queensland, where workable seams do exist, the fossils of New South Wales are also found. In the Secondary marine beds of Wollumbilla and the Amby, gold in minute visible particles was found by me in some of the quartz pebbles cemented with the shells, and a small quantity was detected by crushing the whole, shells, pebbles, and the calcareous cement together.

Tertiary Rocks.

Throughout the whole of Eastern Australia, including New South Wales and Queensland, no Tertiary *marine* deposits have been discovered. There are, however, in various places of New South Wales, patches of *plant deposits* which, according to the frequent notices of geologists, may be referred to some period of the Tertiary epoch. A silicified sandstone, or quartzite, of this kind, full of impressions of ferns and leaves of trees, but not known to be now living, occurs at Jerara Creek, not far from Yass. (See No. 475.) It is probably Miocene. On the summit of the Cordillera, near Nundle, above the Peel River Diggings, occurs a ferruginous bed full of leaves. Both these localities are represented by specimens in the Exhibition. On the Richmond River occurs a white magnesite, full of yellowish impressions of leaves. At Keewong, in the county of Gowen, there is a bluish deposit of fine aluminous matter with black impressions. From a depth of 60 feet in a shaft near Bungonia, a pale yellowish white deposit with similar impressions was brought up; and on the summit of "a made" hill, above Kiandra Gold Field, at a height of 4,000 feet above the sea, and in a region now partly covered with snow many months in the year, there is a deposit of black clay with such casts of leaves as occur in similar clay near Hyde in New Zealand.

No botanist is prepared to declare what is the exact age of such deposits. But some of the leaves are supposed to represent among others the foliage of *Fagus;* yet, it was only in 1866 that a beech forest was discovered, by the Director of the

Botanical Gardens, growing on the Clarence River. On comparing the living leaves with the impressions in the various deposits mentioned, I can see no identity. This is a point in Geology not yet fully dealt with.

The most remarkable instance I have met with is on the coast, about forty-two miles north of Cape Howe, where, at a place called Chouta (between Tura and Boonda) a cliff about 100 feet high, formed of sand and white silicate of alumina, contains beds of lignite charged with sulphid of iron, and which are full of phytolites much allied to the living vegetation. From the clays, some of which are nearly kaolin, articles of pottery have been formed, which, with the clays and sands, are exhibited. (See Nos. 269 & 371.) It has been proved that, by distillation, a fair proportion of lubricating oil may be produced from the lignitiferous clay, and other products are expected to result from these deposits. The cliff is about 60 feet thick from the sea to the top of the clays, and borings below the sea level have shown a still greater thickness.

These deposits lie between the horns of the little bay at Tura and Boonda, resting at one end on the highly undulating Paleozoic rocks, and at the other on a mass of Porphyry. They were, formerly, no doubt, deposited in a depression among the slopes of the hills, but the wearing away of the coast has left a cliff of clay and sand instead of the original cliff of hard rocks. It is remarkable that, at the south end the rocks assume the character of a breccia of quartz, cemented by siliceous matter (probably like a deposit mentioned by Mr. Gould as occurring in Tasmania) and in it analysis has detected the presence of gold, though some quartz veins at the north end contained none.

My impression at first was that the lignite was recent, but I place the deposits under the present head because it may be possible the plants are not recent; and some of the hardened clinker-like sands covering the clays remind me of the sands on the coast of Dorset, at Studland, and Bourne Mouth. If this be really a Tertiary locality, it does not contradict the general assertion at the commencement of this section, for no shells of any kind have been detected in any part of these beds. Swampy and stunted plants still grow on the sands which are very wet, and probably reproducing the phenomena beneath them, with the exception of the white clays which were in part derived from the decomposed felspathic matter of the Porphyry. In various parts of Maneero there are lignite-like local thin deposits, but on analysis they have proved valueless.

It may be well to mention, that although there are no such positive indications as exist in Victoria, as to the age of the

Gold drifts which are by Mr. Selwyn referred to Upper and Middle Tertiary, yet there are parallels in New South Wales to certain phenomena that have been observed in that province. Thus, the gold alluvia of the Uralla resting chiefly on granite are covered by a great thickness of basalt, as in various Victorian fields, and at Lucknow, near Orange, as well as at Uralla, under the basalt and with the gold alluvia are found stems and branches of trees, as is the case at Daylesford, in Victoria.

These may be Miocene, or perhaps Pliocene, but the proof must rest on evidence not yet attainable.

Pleistocene and recent accumulations.

In many parts of the existing region, all over the surface, wherever the basal rock is not denuded, as near Sydney, there are local deposits which might be called "till," were any Testacea found in them; and in the interior there are widely-spread accumulations of drift pebbles, which, as on the Hunter and Wollondilly, are rounded by attrition in their long journey from the mountains whence they have been derived. Sometimes, also, the breaking up of conglomerates has contributed to this drift.

In more than one instance, it is clear that the present river channels have deepened since the drift first began to crowd their banks. I have traced one of these drift streams, sometimes at great heights above the valleys, for more than 80 miles. In other places I have found upon the surface, as Strzelecki did in other parts, minerals (especially ores of copper, tin, and lead) which were at a great distance from their sources; and in two instances, that rare mineral, Molybdate of lead, of which no habitat has ever been yet found.

In the great plains of the interior, bones of various gigantic marsupials, fishes and reptiles, are found bedded in black muddy trappean soil; and on Darling Downs in Queensland, univalve and bivalve shells are found in some cases attached to the bones, or deposited over them in a regular series of layers, at intervals of several feet; and of these shells some are yet living in the water-holes of the creeks. These facts are generally known, but it was not till recently that the osseous relics have been found in different creeks throughout the whole of the slopes and plains at the base of the Cordillera in Eastern Australia.

Similar to this are the accumulations of bones in caverns, as at Wellington—at Boree, near the head of the Colo river—at Yesseba on the Macleay river, and other places.

In the Exhibition is a magnificent collection made by Mr. Krefft, from the former locality, and several specimens of bone breccia from the latter place, discovered by Mr. Rudder. (See Nos. 483e & 469.)

Along the coast are found ranges of Dunes, with a variety of shells, some of them rare, others recent, as on Port Hacking and Cronulla beach; along the shores of Botany Bay; on the great flat between the Hunter and Port Stephens, and along the Macleay river which now passes for many miles through the shelly accumulations; and about Moreton Bay and in more northern coast openings, shells and marine refuse form deep deposits, from which, as in Illawarra and Broken Bay, a considerable profit is obtained by dredgers and shell-collectors, for the production of lime.

Mr. Rudder illustrates the case of the Macleay by collections of the shells, and by a carefully-drawn map defining the limits of the Pleistocene deposits. (See No. 469.)

All along the coast, from Torres' Straits to Bass's Strait, drift pumice may be found wherever there is a lodgment, generally in the north corner of the little shore bays. That this has gone on for ages is apparent, as in one part of the coast south of Sydney there is an accumulation of water-worn pumice, some distance from the shore, and beyond the reach of the present waves. It is supposed to come in during easterly gales, from the volcanic islands to the northeast.

Raised beaches occur also at various heights on rocky projections of the coast, indicating elevation of the land, of which there is distinct evidence in the recent period, not only in Moreton Bay, near Sydney, and thence to Bass's Strait; but on both sides of that Strait, and as far as Adelaide and King George's Sound. Mr. Selwyn gives data for assuming the elevation of the land to have reached occasionally 4,000 feet in Victoria, but he has no evidence of Tertiary marine fossils above 600 feet. Unfortunately, on the eastern coast, having no marine Tertiaries, we have to found our deductions, as respects New South Wales, on less secure data. Yet we have here evidence of another kind, and pot-holed surfaces of considerable extent have been found by me at various heights from 300 to nearly 3,000 feet.

In a brief abstract like the present, it is impossible to quote authorities, nor has time allowed a more satisfactory digest or a wider range of statements. Nor has opportunity permitted the preparation of sections (save of the Newcastle Coal Field, No. 477) or map to point out relative positions of the formations mentioned by me in this paper. The places named can, however, be seen on such maps as are probably exhibited by English publishers; if not, reference can be made to Petermann's map of Southeast Australia, in Stieler's Hand Atlas, No. 50c.

I have not named the occurrence of the ferruginous deposits of the Cape York Peninsula, (though I possess a map, and

collections made from about the new settlement and along the coast), because I am not at present aware whether they are Pleistocene or Tertiary. They are very extensive, and cover the bases of Porphyry hills. On analysis of the ironstone, no gold was detected. W. B. C.

St. Leonards, near Sydney, 17 January, 1867.

ART. XXXVIII.—*The Ainos, or Hairy men of Yesso;* by ALBERT S. BICKMORE, A.M.

(From the Proceedings of the Boston Soc. of Nat. Hist., Dec. 4th, 1867.)

THE islands that now form the empire of Japan are four in number: Kiusiu, on the south, opposite Corea; Sikok, a little to the northeast; Niphon, the great island of Japan, to the north; and Yesso, another large island to the north of the latter. In the most southern part of Yesso, on the wide strait, which separates that island from Niphon, is situated Hakodadi, its chief city, and its only port open to foreign trade.

Arriving at this place on my way northward from Yedo to Siberia, at the solicitation of our Consul, Col. E. E. Rice, the Japanese Governor gave me the privilege of going some miles beyond the places usually visited by foreigners and seeing a real village of the Ainos— the aborigines of these islands and the least known of all the people of the east.

From Hakodadi I travelled northward over a mountain range to the active volcano Ko-man-ga-ta-ki, and descending its northern flanks came to the village of Mori on Volcano Bay. Here for the first time I had the privilege of seeing a man and woman of that strange people.

From Mori we followed the shore for fifteen miles to Ya-ma Koosh-nai, sometimes over loose sand, shingle, or boulders, and sometimes along the little paths that lead from one fishing village to another, in a neighboring bay. Terraces extend the whole way, occasionally coming down to the shore and forming bluffs one hundred or one hundred and fifty feet in height, but back of these was another series as much higher. The fishermen near the head of the bay were taking fishes much like our herring, in great quantities, for their oil. The residue in the boiling pots is pressed into square masses and exported as manure for rice fields. There we saw many Ainos at work with Japanese, but usually they prefer to work in companies by themselves.

From Ya-ma Koosh-nai we travelled five miles to Urope, a village of three or four Japanese, and about twenty Aino

houses. The latter were scattered irregularly near the shore over a broad belt of sand, that has been drifted back by the easterly winds. They all have the same rectangular form, and are similarly situated in respect to the shore.

The best are composed of a house part about thirty feet long and twenty broad. To this is attached a porch about twelve feet long and eight broad, and around the whole is a straw fence. The house and porch are built of a frame-work of small poles fastened together with strips of bark and covered with millet straw. The walls are about four feet high and slightly sloping. The roof projects a few inches at the eaves and rises from each side to a point in the center. In the walls, under the eaves, there are two or three holes a foot in diameter, which serve as windows. In entering, you pass through the straw fence into the porch, and thence through a door into the house. The house part is generally one room, and also the porch; but in a few, a kind of partition is made in the larger room by hanging up mats. Most of the houses have no floors, but instead the sand is covered with mats of coarse straw, and on one side of the room there is a platform of boards on stones or blocks of wood, where the occupants lounge and sleep. They usually sit on the mats on the sand. In the center of the room the fire is made on the sand, and over this and about three feet above it, is a kind of frame-work held up by strings from the rafters, where they place the fish they wish to smoke. It also serves for a cupboard or dresser, where the smaller iron pans and kettles may be put away. There is no chimney, and I did not even see a hole in the roof for the smoke to escape. Everything overhead is, therefore, black with smoke, and generally has a shining, oily appearance. Each house is provided with a few iron pans and kettles of Japanese manufacture, and these, with two or three wooden dippers, and some large valves of the pecten, comprise their cooking utensils. They make a fire by means of a flint, steel and tinder, which are usually kept in a bag of undressed deer skin. In several houses I saw a considerable number of lacquered dishes, which they had evidently obtained from the Japanese. Near each house there is another small one about eight feet square, perched on a platform five or six feet high, in which they store their fish, in much the same way as the natives of Sumatra preserve their rice. In the first house we entered, the man was seated cross-legged in one corner making spears, with a fire of charcoal and a Japanese bellows. The woman was crouched near the fire, twisting up thin strips of the inner layer of the bark of a tree into a continuous line of the size of a mackerel line. It is from such material, and in this way, that all the lines for

their fishing nets are made. They had four children; all boys, the youngest two and the eldest ten. The two younger ones had no clothing on whatever, and the other two were only provided with a long jacket, though it was quite chilly. With such exposure evidently a large proportion of their children must perish.

In the next house we entered—the dimensions of which I have given above as a model—we found an old man, his son, and three women. The old man said he was seventy-five, and his white hair and white beard made it appear probable, yet a young woman, apparently of twenty, was presented to me as his wife. She was demurely at work in one corner, making a straw mat after the Japanese style. The other young woman was weaving a piece of cloth about ten inches wide, from strings made of bark as already described. These strings, which represented the warp, were fastened at one end to a post and at the other end to a board which she kept leaning against while she changed them and pushed through the filling and pressed it down with a sharp edged board. This kind of cloth seems to be the only one they have, and it is all made in this slow and laborious manner. In front of this house, that is, on the side toward the shore, there was a kind of rack filled with sticks, each having on its top the skull of a bear. In this single place I counted twenty-nine skulls of this animal, a number that must make our old friend and his son rank high in the estimation of his Aino companions. In another house we entered, we found a man and his wife seated by the fire. The woman was sewing, but the man was doing nothing, and yet the bay was swarming with fish. He showed us the bow he used in hunting the bear, but would only sell a model of it, declaring that in their estimation it was most disgraceful for an Aino to part with the bow he was accustomed to use. However I secured a real arrow. The after part of the shaft was of reed, the fore part of solid wood to make it fly point foremost, and the barbed part of bamboo. They carry short knives, but they appear to rely on their bows and arrows when they attack a bear or kill a deer. I saw no lances, nor any implements of stone or bronze. I also purchased of this man a pair of snow shoes, each made of two strips of wood bent like an ox bow, with the straight part fastened together with deer skin. The woman sold me a short knife, with a scabbard of wood and ivory, rudely chased. It was the only piece of ornamented work I saw. As I was anxious to ascertain the height, the distance round the chest, and the length of the arm, hand, and foot of an Aino woman, my interpreter bribed the husband with a small piece of silver to make the desired measurements, but the paper

was unfortunately lost, and now I can only state from memory, that the peculiarity which struck me most was, that the regions of the waist and chest did not appear as separate as in most women; but it remains to be seen whether this is a permanent character. The mammæ were very largely developed, and gourd-shaped.

When a woman marries they tattoo her upper lip and sometimes the under one also. A favorite pattern has the ends curved up, in just the way exquisites sometimes curl up the ends of their moustaches. Several times I inquired, what was the cause or origin of this strange custom, but invariably received the unsatisfactory answer—"because it is the Aino fashion"—which is, perhaps, as good a reason as could be assigned for a thousand foolish customs in the most civilized lands. At all events it gives these Aino women the appearance of trying to add to their charms by artificially making up for what they seem to consider a defect in nature's handiwork. The women also tattoo the backs of their hands in narrow transverse bands, but no other parts of the body. They never blacken their teeth, or compress the feet. In each Aino village, the oldest man, or a very old man, is the chief, and he in turn is responsible to a Japanese official styled "the Aino Interpreter." As the chief was away fishing, we called on the Interpreter, who was also absent, but a sub-official gave me some farther items in regard to the strange people under his charge. They cultivate millet and potatoes, but no rice. In one hut I saw the thick midrib of some wild plant finely chopped. When they kill a bear, they are allowed the head, but the skin belongs to the Interpreter. They are permitted however to wear deer skin, and the woman I saw first at Mori had on an outer dress of that kind. It is said that when young cubs are found they are brought home and nursed by the Aino women like their own children, but this is quite incredible.

Returning to Ya-ma Koosh-nai, I continued on to Mori, and made that day twenty-five miles over the sand, rocks and shingle. The next day I reached Hakodadi, thirty-two miles—whole distance on foot in six days, one hundred and thirty miles. On my return I found that eight Ainos had just arrived in a couple of junks from a place on the south coast, a short distance east of Endermo Bay. With the prospect of a small present they readily came to the residence of Colonel Rice, whose kind hospitality I was then enjoying. They all sat down cross-legged, in the Turkish style, not in a semi-circle like our American Indians, but in a straight line, the oldest man on their extreme left, the highest position of honor, and the rest arranging themselves according to their ages, to the

youngest on their right. They could not tell, however, how old they were, but said that the Japanese officials kept a record of their ages. As soon as they were seated they began their salutation, which consists in slightly inclining the body forward, at the same time raising both hands as high as the eyes, with the palms inward and the fingers extended and nearly touching each other. The hands then pass down along the beard to the chest. This is repeated three times, and when they wish to show still greater respect they accompany these motions with a low guttural muttering. Saki (Japanese rice-whiskey) being their favorite drink, each was offered a glass and a chop stick. Taking the glass in the left hand and the stick in the right, they dip the end of the stick into the liquor they are about to drink, and slightly raising it describe a circle with an upward and inward motion. While describing these motions with the stick, they uttered a long prayer, in a low monotonous tone. This prayer, they afterward informed us, was not in our behalf, in return for the saki, but addressed to the god of the sea, asking that they might be preserved in their boats, and find an abundance of fish. One of their number spoke Japanese fluently, and Mr. James J. Enslie, the Japanese interpreter at the British Consulate, and himself the author of two interesting papers on the Ainos, kindly volunteered to ask them a list of questions I had prepared. In this way the following information was obtained directly from the Ainos themselves. As some of the questions proved quite perplexing, they became tired before the list was completed, and I failed therefore to get replies to all my queries.

They have many gods, but fire—not the sun, the moon, nor the stars—is the principal one, and they are accustomed to pray to it in general terms, for all they may need. They do not buy their wives, but are expected to make presents to her parents of saki, tobacco, and fish. At their marriages they make no great rejoicing or display. Their only feast is at the beginning of the new year, when they make offerings to all the gods. When a wife dies they burn the house in which she lived, but when a man dies they bury him without any funeral ceremony (perhaps the Interpreter meant if he was a common man). To inter a body they dig a hole in the ground and lay in planks in the form of a box. The body is then clothed in *white*, and placed in at full length, with the head to the east, "because that is where the sun rises." A widower may marry again in two or three years, but a woman can only marry once. (This the Interpreter probably intended to say was their law but not the universal custom.) A man can have only one acknowledged wife, but any number of concubines,

each of whom always lives in a separate house. At present they have no king, but a great chief living at Saru. The Interpreter had met other Ainos whom he could not understand (that is to say, there are at least two different dialects in the Aino language). They keep no cats but catch rats in traps. They have "only Japanese horses." They keep fowls but no ducks. They eat their fowls and what wild birds they can take, but never eat *eggs*. They have no special burying grounds, and they desire only to forget their deceased relatives as soon as possible. The never speak of the dead, and if a man should call on a friend, and inquire for his deceased wife and say "Oh! is she dead?" such an act would be considered the grossest breach of good breeding. They say that they can make poison, but refused to tell how, and further declared that they kept it such a secret that even the Japanese officials knew nothing of the process. They have sorcerers whose advice they are accustomed to ask. A Japanese doctor who had lived long among them told me that when a man was lost at sea or among the mountains, his wife cries, and all her neighbors beat her with sticks to make her forget her sorrow. When the Interpreter was asked what would become of him after he died he replied he did not know, and when he was asked if he expected to go to a place of happiness or a place of misery, hereafter, he simply laughed as if he did not understand the question or thought it extremely foolish. They have no written characters, and only oral traditions.

After this questioning, I took the following measurements of two of them and add those of a man seen at Mori :—

	No. 1.	No. 2.	No. 3.
Height,	5 ft. 1⅞ in.	5 ft. 2 in.	
Distance horizontally round the head just above the eyebrows,	1 " 10⅜ "	1 " 10 "	
Distance round the chest immediately beneath the arms,	2 " 10 "	2 " 10½ "	2 ft. 10⅝ in.
Distance round the abdomen at the navel,	2 " 7½ "	2 " 9½ "	
Length of the arm to the middle finger,	2 " 2½ "	2 " 4½ "	2 " 1¾ "
Distance round the arm at the largest part,	10½ "	10¼ "	
Distance round the forearm at the largest part,	10⅛ "	10⅝ "	
Distance round the leg at the calf,	12½ "	12½ "	
" " " foot vertically,	10½ "	10 "	
Length of the foot,	9½ "	9⅞ "	

These measurements were made from men of medium size. They show, therefore, that although the Ainos are stout and strong, they are hardly taller than the Japanese, and not near as tall as the average of the people in the north of China. The relative size of the hands and feet to the rest of the body seems to vary considerably. I saw no lame persons and but

one man who complained of being ill, though several had evidently reached an advanced age.

One of their chief peculiarities is the great development of their hair, not only the head and face, but over the whole body. Their eyebrows and eyelashes are very thick, and like their beards and hair, always of a jet black, till past middle life, when, as with us, they change to gray and in extreme old age to white. Their hair appears coarse compared with ours or with that of the Japanese. They wear it long—down to the shoulders. The men wear theirs as long, or longer than is the custom with their women. Their eyelids are *horizontal* and open *widely*, as in the Indo-European races, and are not *oblique*, and open but *partially* as in the Mongols, Manchus, Chinese, Japanese, and also the Coreans, all of which peoples it has been my privilege to see in large numbers. Their eyes are bright and sparkling and always black. The fine development of their chests, with their full heavy beards, gives them the appearance of noble and hardy men as compared with their effeminate Japanese rulers. They seem to be endowed with great vitality, and the fact that they so successfully resisted the repeated attacks of a more enlightened race for eighteen hundred years, sufficiently proves their daring and perseverance.

The dress of the men consists of a strip of cloth covering the loins in the same way as is customary among coolies in the East. In summer this is their only clothing, but in winter they wear long, loose coats, or dressing gowns woven from strings of bark. This is folded over from right to left* and bound at the waist with a sash. Their heads, feet, and legs are usually bare. The women have a shorter dressing gown coming down to the hips, and beneath this a piece of cloth wrapped around the waist and hanging down nearly to the knee.

As they have no written records, the earliest accounts of this people have come down to us through Japanese histories. According to a Japanese chronology compiled from the best sources and kindly translated for me by Father Nicholai, for the Russian Legation, Jin-mu the first Japanese emperor appeared on Kiusiu at Hunga (or Hewng-nga) in B. C. 667. In B. C. 663 he first came to Niphon, but was defeated and driven back by the aborigines. In B. C. 660 he returned and effected a permanent settlement on the southeast part of that island. In most of the Japanese histories, at least, no mention appears of the arrival of any new people, and the Japanese all believe

* This is the manner in which the Japanese females fold their dresses. The Japanese men fold theirs from left to right.

that these aborigines were the ancestors of the present Ainos. Thus, this people, although so little known to this day, are mentioned half a century before the time of Nebuchadnezzar, and *six hundred* years before the northern and western parts of Europe were first described by Cæsar in his Commentaries, and more than *two thousand one hundred* years before the discovery of the continent by Columbus. In A. D. 272 the Ainos, for the first time, brought presents to the Japanese authorities and acknowledged them as their rulers. In A. D. 352 they rebelled. and in the year 366 they defeated the Japanese and killed their general. During the next two centuries, however, they appear to have been completely subjugated; for an educated Japanese informs me that as early as A. D. 655, the Japanese sovereign then reigning established a kind of government over the Ainos in Yesso, which was located near Siribets, a volcano on the north shore of Volcano Bay. In A. D. 1186, Yoritomo usurped the ruling power in Niphon, and becoming jealous of his brother Yosi Tsunay, had him put to death according to history, at a headland on the east coast, now called Shendai. But according to tradition, Yosi Tsunai escaped to Yesso, and treating the Ainos here with the greatest kindness, was deified by them and is now their chief hero.

Although the Ainos had long been conquered by the Japanese, some of them yet lived on Niphon till about two hundred years ago, when they were all banished to Yesso. The same educated Japanese informs me that up to a short time ago, the ruins of a rude fortification, probably made by the Ainos, were to be seen at Nambu point, the most northeastern part of Niphon; and that similar ruins are reported to still exist among the mountains in the northern parts of that island. In Yesso, some ruins of a rude kind are reported at Saru, a village on the south coast, in the longitude of Cape Yesan at the entrance of Tsugar Strait; and—as the Aino interpreter previously said—the chief descendant of the old Aino kings (and therefore their chief prince) is now living at that place, and claims to possess some of the presents made by Yosi Tsunay to his ancestors.

In their eyelids which are horizontal and open widely, in the abundance of their hair, and in the full development of their chests, these people differ totally from the Chinese, the Japanese, and the Coreans on the south, the Manchus on the west, and the Gilyaks and Kamtschadales on the north; but in these same characters they call to mind the bearded peasants in Russia of the Slavonian branch of the Aryan family.

Are they, therefore, an extreme branch of the North Turanian family, or, as is more probable, in the same manner that

the Indo-European races migrated from the high plateau of Central Asia through the plateau of Iran to the west, and the Persians and Indians to the south, did another part of that same family pass on to the east until they finally reached the islands now forming the Empire of Japan; and do their living representatives now appear before us in the persons of this isolated and ancient people, the Ainos ?

ART. XXXIX.—*The Ainos, or Hairy Men, of Saghalien and the Kurile Islands;* by ALBERT S. BICKMORE, A.M.

[Read before the Boston Society of Natural History, March 4, 1868.]

LAST spring, while at Hakodadi in the southern part of the island of Yesso, I forwarded to the Society a short paper containing some observations on the Ainos living on Volcano Bay. It was my determination at that time to go north along the whole western coast of Yesso to La Pérouse Strait, and crossing that in some junk, make my way up along the western shore of Saghalien to the Russian posts, if the Japanese government would allow me to undertake such a journey, but this privilege they would not grant. I therefore most gladly accepted a kind proposition from Capt. Susloff, of the Russian man-of-war Morse, to take passage with him up the Gulf of Tartary to the mouth of the Amoor.

Immediately after the date of the communication referred to, June 1st, 1867, we steamed out of Tsugar Strait for the opposite coast of Manchuria. A pleasant passage over the Japan Sea brought us to Vladi Vostock, the extremity of the great empire of Russia toward the east. Thence, our course was northeast to Kusyunai on the western coast of Saghalien, in about lat. 48° N. At this small post there was only a lieutenant, a doctor, and a few soldiers. Their log houses were back of a sandy beach on a low meadow, through which coursed a small stream. This stream had been the boundary between Russia and Japan up to the time of our arrival; but when we came to the Amoor, we found that a treaty had already been made between the two powers, to hold all the Kurile Islands (or all but one of those Islands), and the southern part of Saghalien, "in common."

At Kusunai I had the privilege of seeing a few of the Ainos of Saghalien. In their features, in their customs, and in every respect, they appeared to agree perfectly with those I had seen on the shores of Volcano Bay, and others who came to Hakodadi from the south coast of Yesso east of Endermo Bay.

Their huts were across the stream a short distance to the south, and we remained so short a time I was unable to visit them.

Whittingham,* who landed north of Cape Lamanon, and but a few miles from this place, thus describes the houses he saw there: "As we came near the shore, four dark men, with very long black hair flying in the wind, and clothed in seal-skin jackets, kilts and boots, waved their arms and hands, warning us to another landing-place, toward which they waddled with a peculiar clumsy gait. With many demonstrations of respect they led the way to their huts of rough logs, covered and the interstices filled with birch bark and dry leaves; they were low on the ground, and could only be entered by stooping on the hands and knees. The larger huts were used as store-houses for their fishing apparatus. One of the men was a magnificent savage, tall, lithe, straight and strong, with hair, beard and moustaches never desecrated by the touch of the scissors; with a high broad brow, dark eyes, straight nose and oval face, he was a far nobler creature than the Red Indian, who I had always fancied was the pride of wild men. His fellows were less manly in their bearing and smaller; and as far as dirt, mal-odor, and want of light permitted me to see, the women were ugly and little." The *oval* form of the face, which is here noticed, is very correct; but he is mistaken, however, about the stature of the women, which, in those I saw, was nearly equal to that of the men. I measured one man and found his height to be 5 feet 3¾ inches, nearly two inches taller than those I measured in Yesso. The distance round his chest was 3 feet 2 inches; stretch of arms across the chest, 5 feet 8¾ inches; length of arm, 1 foot 2 inches; and of fore-arm, 1 foot 6 inches; distance round the arm at the biceps, 10 inches; round the calf of the leg, 12¼ inches; and round the hand, when open, 7 inches. One of these aborigines had a remarkably large head, a light almost florid complexion, and such regular European features, that we all remarked that if he were to be clothed in European costume and transported to the western world, no one would imagine that he was a native of the northeastern part of Asia. Rollin in La Pérouse's voyage gives the following valuable measurements of the head of one of these people: circumference, 23·80 inches; its longest diameter, 10·30, and its shortest diameter, 6·83 inches. This shows their full cerebral development. Unlike those Mr. Whittingham describes, all the Ainos that I saw had cut off the hair on the front part of the head in the

* Notes on the Expedition against the Settlements in Eastern Siberia. London, 1856.

same manner as is the custom with the Japanese. Whether they were obliged to do this by their Japanese masters as a token of their submission, I was not able to learn. On Yesso some do and some do not cut off a part of their hair, and this is said to be the case on those Kurile Islands that have long been under the Russian government, and where the Japanese officials could not compel these people to follow their peculiar fashion.

During my stay at Nicholaifsk, at the mouth of the Amoor river, I met a Cossack who had been sent down to this part of Saghalien to live among this people in order to learn their customs and acquire their language. He gave me the following information in regard to that part of them that live on that island: The Aino name for Saghalien is Karapto They have no written characters, but the old men can send intelligence to each other by means of sticks notched in different manners. They are superstitiously afraid of the Japanese, and believe that they have supernatural power to injure them, and can at pleasure cause them to sicken and even die. When a man dies they bury him clad, not necessarily in white, but in the best suit he may happen to have, and usually in furs when he possesses any. The bodies of persons of all ages are placed at full length in boxes, with the face upward. At such times they all cry and mourn very bitterly, even to the children. The Cossack said that one time he wanted a little child that was visiting her parents, and when he came to their house he found her crying with the others over the loss of a friend. When a widow laments, they do not beat her with sticks as a Japanese doctor reported to me was the custom of the Ainos on Volcano Bay. Every friend who comes to mourn with a widow is very careful not to mention her husband's name, not from any superstitious fear of the dead, but for fear of reminding her of her loss, and thus adding to her sorrow. When a man dies, the next youngest brother takes the widow as his wife, either for life or until she has an opportunity to marry again. A widower may marry again in a month, but a widow is expected to remain single somewhat longer. They have no marriage ceremonies. A man does not buy his wife but works for her father. A man may have two or three wives; the Cossack did not know any man who had more than three. (The Gilyaks, their immediate neighbors, usually have two.) If a woman is unfaithful, the husband merely reproves her, and if no one but he and the guilty parties knew of it, he would probably not mention it to any one. When a woman is in labor, she remains with the other members of the family, but is kept from her husband for one month afterward.

They reckon time by twelve moons or months, and three seasons: when the snow melts, when the flowers appear, and when they fade. When any one is sick they sacrifice a dog on the top of a mountain—the higher the mountain the more they reverence it. The Cossack thinks that they believe in a Supreme Being, and that they only pray to the mountain to intercede for them with this exalted Deity. They are naturally a very reverential people, and do worship the sun, the moon, and the stars, but only as intercessors, according to the Cossack. (Their religion may be regarded as a modified form of Shamanism).

They keep dogs to travel with in winter and also use them for food. They have no cattle, and do not cultivate the soil, but the Cossack thinks that they would, if they were taught to do so, because they are not lazy like the Gilyaks (and every other branch of the Mongolian family).

They eat a kind of wild root as we do the potato, but they never cultivate it. They eat eggs. The Japanese have introduced cats among them. They have no mice, but thousands of rats, which they catch in traps, but not for food like the Chinese. The Cossack believes that they were never guilty of stealing before they learned the habit from the Japanese! For a theft, a man is fined, but such offence rarely occurs. Their women do not suckle young cubs as has been asserted on doubtful authority of the Aino women of Yesso. When the bears are grown, they kill them and eat them, and have a great feast. They do not worship the bear, but merely raise him and kill him in order to make a festive occasion.

Formerly they used implements of stone and bone—those of the former until quite lately. Now they have iron, but probably do not know how to get it from the earth themselves.

In regard to their origin, every village gives a different legend.*

What the Cossack has said in respect to their raising and killing the bear is exactly true of the Gilyaks as they represented their customs and notions to me.

* The southern half of the peninsula of Kamtschatka is occupied by the *Kamtschadales*, also called *Itulms;* and the northern half by the Koriaks. The very northeast corner of Asia is the territory of the Tchuktchis. The following habits of the Koriaks and Tchuktchis, compiled from Mr. Pauly's great work, will show the similarity of the customs of those peoples with the customs of the Ainos given above:—

The Koriak women tattoo themselves, because "they hope in this way to repair the ravages of time." When a Koriak will marry, he must bring presents to his expected father-in-law, and if these are accepted, he must also enter into the lowest service for his new parent, such as tending the reindeer or bringing wood. He never speaks to the young lady, and moreover she is allowed no voice in the matter whatever. If the young man pleases the father, he gives him his daughter, and a recompense for his labor, which is sometimes continued for *ten* years.

The number of this people on Saghalien was very carefully ascertained in the year 1857 by Lieut. Rudanovsky, who was sent here by the Russian government for that special purpose. The locations of the villages and the number of houses or "yurts," and the population they contained, are given as follows in a newspaper published at Nicholaifsk at that time :—

On Aniwa Bay,	east shore,	in	25	villages,	91	yurts,	and	535	persons.
" " "	west "	"	10	"	46	"	"	143	"
" the Ohkotsk shore,		"	22	"	64	"	"	473	"
" " coast of the Gulf of Tartary,		"	35	"	129	"	"	1,268	"
In the middle of the island along a river,		"	3	"	10	"	"	60	"

Total on Saghalien, 95 villages, 350 yurts, and 2,479 persons.

As these people subsist almost solely by fishing, I judge that there are not more than three or four times this number on Yesso and the Kurile Islands. This would make their total population from 10,000 to 12,000. Those given above as on "Ohkotsk shore," live on the northern extremity of Saghalien, along the bay between Cape Elizabeth and Cape Maria. All the central part of Saghalien is occupied by the Orochi, who live in the higher and more mountainous parts, and the Gilyaks along a part of both the eastern and western shores.

The isolated fragment of this people at the northern part of Saghalien is very interesting, because it indicates at once, that the Ainos were the aboriginal inhabitants of the island, and that the Orochi and the Gilyaks have come over from the continent at a later period, across "the Liman" or narrow strait between 52° and 53° 30′ north.

A line drawn along the high land from Cape Patience on the east coast around the head of the gulf of that name, and thence northwest to the village of Pilyavo on the Gulf of Tartary in about 50° 10′ N., would be the northern limit of the area these people usually occupy in the southern part of Saghalien. Occasionally, however, they go northward on trading

If the father does not fancy the proposer, he is discharged and gets no recompense for his long, tedious toil. When he receives his wife, one more apartment is made in the yurt, and his future parents and neighbors beat him with sticks. If he endures this manfully, he proves his ability "to bear up against all the ills of life," and is then conducted without farther ceremony to the apartment of his betrothed. Polygamy is allowed, but all of the foregoing formalities are not observed, especially if the man is rich. They believe in an existence hereafter much like that of the present.

The Tchuktchis allow polygamy, but do not pay the *kalym* (a price for the bride). When a young man wishes to marry, he goes to the father and gets his favor, and tends his reindeer; and after having served for a short time in this capacity, he is married if the young lady consents. The rich get their wives without serving the bride's father, and often without paying a *kalym*. The lady chosen is usually a *cousin*. Divorce is frequent, on account of disputes between the husband and his wife, or trouble between the wife and her mother-in-law.

or hunting excursions in winter to the Tymy river, which flows eastward and empties into the Ohkotsk Sea in latitude 50° 50′ N. Though I took much pains to inquire at Vladi Vostock and at Castries Bay of those persons who have been along the whole coast of Manchuria, I could obtain no indication that there is a single Aino now living on the continent. Afterward, while ascending the Amoor and the Usuri, I met fur traders who had passed to and fro over all the area between those rivers and the sea-coast, and they all confirmed this statement. The people at Castries Bay, described by Mr. Rollin in La Pérouse's voyage, were probably Gilyaks, the same people who live there now. The fact that the Ainos, unlike the Gilyaks and the Tungusic tribes, prefer to remain quietly near their homes, makes Rollin's statement improbable, and the error he made appears to have been repeated by nearly every ethnologist down to the present day.

Besides all the great island of Yesso, and the parts of Saghalien described above, these aborigines certainly inhabit all the Kurile Islands from Yesso to Paramushir, the next island but one to Kamtschatka, and according to some authorities, the extreme southern part of that peninsula also.

The earliest notice of this people by the Japanese historians has already been given in the previous paper, as occurring as early as 663 B. C., *more than half a century before the time of Nebuchadnezzar.*

The first European who has mentioned them in his writings was Père Aloisius Froes, in a letter dated at Miako, the capital of the spiritual emperor, March 1st, 1565 (twenty-two years after the discovery of Japan by the Portuguese). He thus describes this people,* though he does not give us to understand that he had ever seen them: "In the north of Japan, three hundred *leucas* (about 17 degrees), lies an extensive province inhabited by savage people. They are clothed with skins, are hairy all over the body, have terribly long beards, and very long moustaches, which they lift up with a small stick when they wish to drink. They are fond of strong drinks, are bold in war, and much feared by the Japanese. If they are wounded in battle they wash their wounds with salt water; this is their only remedy. It is said that they carry a mirror on the breast. They bind swords to the head in such a manner that the handle hangs down on the shoulder. (They now carry all bundles on their backs with a strap passing around the forehead.) They have no religion; it seems that they are used to pray to heaven."

* Elucidations of De Vries' Voyage by Von Siebold, p. 98.

The next account of this hairy people appears in a letter from the Jesuit, Père Hieronymus de Angelis, written in Japan in 1622, a year before he was burnt at Yedo.* In the year 1620 he reached Saghalien, according to Krusenstern, and was probably the first European who had made his way so far through the Japanese empire. As he not only saw the Ainos, but lived among them, his descriptions are authoritative.

"As for the appearance of the inhabitants, they are coarse and of larger stature than men generally are: more inclining in color to white than to brown. They wear long beards, sometimes down to the middle. They shave the hair of the forehead half off, so that they have no hair on the temples, but a good deal behind, and some wear it as long as the Japanese. In general, they have the ears bored, and have silver rings in them instead of pendants: those who have no silver run a flock of silk through the hole and let the ends hang down long. This is done both by men and women. The dress of both sexes is long, interwoven with silk, embroidered with ornaments of crosses or roses of the same stuff, large and small. Their stuffs are of silk, cotton or linen. For arms they employ arrows, bows, lances and swords, which last are not larger than an ordinary Japanese poker. Instead of armor they have coats of small planks fastened together, which is ridiculous to look at. They have poisoned arrows which give an incurable wound. They are very quarrelsome, though they seldom kill one another." (This last statement is the only one of the kind made by any writer; but it is mentioned in the Japanese history of Sintuism, that they were the more easily overcome, because they were divided into a number of separate and independent tribes.) "The lord of Matsmay assured me that the inhabitants of Yesso went to three islands not far distant from their country, the inhabitants of which had no beards and a very different language from those of Yesso, to purchase fish-skins, which they call *raccoon*. But he did not know whether those islands were to the south or north of Yesso." (These people who had "no beard" and had "fish-skins" to sell, were without doubt some of the Tungusic tribes, on the shores of the continent, or perhaps the Gilyaks, who at that time certainly inhabited the islands in Tugur Gulf north of the mouth of the Amoor, and who chiefly dress themselves in fish-skins now. The Tungus on the middle Amoor had probably been supplied with cotton stuffs from China for centuries before that date, A. D. 1565.)

"As to their knowledge of another world and of a future

* Witsen's "Noord-oost Tartarye," and Siebold's De Vries, p. 99.

life, it is little or nothing. They have some sort of worship for the sun and moon as the two greatest lights; as also some mountain and sea devils (spirits); for as they mostly support themselves in the sea with fishing, they hope by these means to catch much, and never be in want of wood for fuel or building. They have neither bonzes, nor priests, nor temples, nor any place where they can come together to do anything for their salvation. None of them are able to read or write. Each one has his own lawful wife, or as some suppose, even two: though there are many who have concubines in the Chinese manner. A woman taken in adultery has the hair of her head shaved off, that she may thus be known; and the adulterer, or he with whom she has committed the crime, is deprived of his sword and of all his ornaments by the offended husband, or by his friends as often as they meet him."

At the present time no Aino carries a sword, and it is probable that the Japanese compelled them to deliver up all such weapons as tokens of their entire submission.

John Saris, who visited Yedo in 1613 as ambassador from the English Company, heard of these people and gathered some accounts of them from the Japanese. Also Françoys Caron, chief of the Dutch trade in Japan during 1639 and 1640, gives some notices of them.

In June, 1643, Capt. Vries, in command of the *Castricum*, sailed up past the eastern entrance of Tsugar Strait, and thence coasted along the eastern shores of Yesso, and anchored near Atseki. The Ainos then living there seemed to be independent of the Japanese, as they now are in the interior of the island. These people had their own forts, such as will probably be found hereafter among the independent tribes. They are thus described:*

"These forts were made as follows: on the mountain on which they were placed was a small road steep to climb, and round on the four sides palisades were placed of the height and length of 1½ man's length; within this stood two or three houses. There were large fir doors in the palisades with strong clamps; when they were closed, two stout bars were passed through the clamps and thus fastened to them. At two corners of these square placed palisades, a high scaffolding is made of fir planks, for a lookout; further, the palisades are well fastened together with cross bars."

In comparison to the present poor and wretched condition of these people under the severe rule of the Japanese, Capt. Vries gives us this picture of the arms worn by the natives of Aniwa Bay, while they were yet free. "Their arms are bows and

* Siebold's Elucidations of C[illegible]-Vries' Voyage, p. 115.

arrows, together with a hanger, much like the Japanese, the blade *inlaid with a thin silver border*; they bear it with a girdle in the Persian manner; the quiver, with a band round the head, hanging on the right side."

"In both the Gulf of Patience and Aniwa Bay they were very desirous of *iron*, giving in exchange feathers and fur, knowing very ingeniously how to pack up the feathers of boxes."

"They offered me a fine otter-skin, for which I gave an old ax with which they were very glad. How much silver we might offer them they always preferred *iron* to *silver*. These people are very fond of silk stuffs, for which they offered furs and *silverwork* in abundance."

The only ornaments or articles of silver they have now are their earrings, which are made of a piece of silver wire about one-tenth of an inch in diameter. This is bent into a large ring about an inch and a half or two inches in diameter, and where the two ends are joined, a glass bead, generally of a blue color, is added. These they appear to prize very highly, for while I was examining one at Volcano Bay, the owner seemed greatly troubled for fear I should take it out and carry it away. Occasionally these rings are made of brass.

"Their bows are four or five feet long, of ash or elm, and the arrows about half a yard, very cleverly made with a small reed harpoon at the end, rubbed with black poison, so that whatever is wounded with it must immediately die."

"They have also traps which, being bent like a bow, there is a round hole made in the wood of the bow, in which they lay some bait; the birds, such as mews, eagles, snipes or ravens, coming to pick in it, or putting in their feet, the bow springs up and the bird is caught."

"Their dogs, taught to catch fish as naturally as can be imagined, lie in wait on the shore of the sea or the banks of the river, and release each other as if they were men, when one has been a certain time on the lookout. The rest of the dogs, in troops of ten or twelve, run along the stream, and when they see any movement of salmon, they rush into the water, swimming in a half moon. The salmon, alarmed, jump out of the water into places where there is little or no water, where they are seized by the dogs on the lookout, who bite off their heads and bring the bodies to their masters, and then return again to their post. This takes place at low water." He thus describes how those people whom he saw were accustomed to make fire: "They had their instruments for making fire with them; these were square planks with a

hollow in them; then they have reeds into which is inserted a short stick; when they want to make fire, they put the short stick in the hollow and rub it between the hands, so that it turns round, and so being dipped in sulphur, they hold that to it and soon have burning fire."

In 1698 Kamtschatka became known to the Europeans, and fifteen years after a Cossack reached Kunashir, the twentieth island in the chain from the continent. In 1736 Spanberg left Petropaulski and visited the Kurile Islands, so-called from the Russian word kuril, "to smoke." After Spanberg's voyage these people were known as "the Kuriles" or "the Hairy Kuriles," and as early as 1764, a book was written by Krasheninicoff,* which contained a more minute and complete account of the appearance and habits of that part of this people than any work I am able to find. Their religion and character are thus described:

"They are as ignorant of a Deity as the Kamtschatdales. In their huts they have idols made of chips of wood, or shavings curiously curled. These idols they call *Ingool*, and are said to venerate in some degree, but whether as good or evil spirits I never could learn. They sacrifice to them the first animal which they catch; eating the flesh themselves, they hang up the skin before the image, and when they change their huts they leave the skin and idol there. If they make any dangerous voyage, they take their idol along with them; which, in case of imminent danger, they throw into the sea, expecting by this method to pacify the storm, and with this protection they think themselves safe in all their excursions." A similar account is given by Capt. Vries of the Ainos on the eastern coast of Yesso and the southern part of Saghalien. He says: "When they sit round a pond and drink, they first pour out a few drops in several places round about the pond, as if they sacrificed. They have some cut fir sticks with shavings hanging to them, which they stick into the earth in many places, and hang them to the walls in the houses. When any one among them is ill, they cut long shavings off these sticks, and wind them round the head and arms of the patient." These sticks Siebold thinks agree with the *Sinto* of the Japanese, and are symbols of divinities in their ancient religion. This history of the Kuriles also represents them as "more civilized than the neighboring people, being steady, honest and peaceable. They have a respect for old people, and an affection for each other, particularly their relatives. It is a pleasure to see with what hospitality they receive such as

* History of Kamtschatka and the Kurilski Islands. Translated by James Greve. Lond., 1764.

come to visit them from other islands. They have an extraordinary way of punishing adultery: the husband challenges the adulterer to a combat, which is performed in the following manner: both the combatants are stripped quite naked, and the challenger gives the challenged a club, about three feet long, and near as thick as one's arm: then the challenger is obliged to receive three strokes upon his back from the challenged, who then returns him the club and is visited in the same manner; this they perform three times, and the result is generally the death of both combatants. If any one prefers his safety to his honor, the adulterer then is obliged to pay the husband of the adulteress whatever he demands, whether in skins, clothes, provisions or other things. When twins are born they always destroy one. The men shave their heads as far back as the crown, allowing the other hair to grow to its full length. The women only cut the fore part of their hair, that it may not fall into their eyes. The lips of the men are blackened about the middle; the women's are entirely black, and stained round; their arms are likewise stained with different figures as far as the elbows. This custom they have in common with the Tchuktchi and Tungus. Their clothes are made of the skins of sea fowls, foxes, sea otters, and other animals; and are generally composed of the skins of very different creatures, so that it is rare to see a whole suit made of the same sort of skins."

Capt. Golovnin, in the memoirs of his captivity, informs us that he had a native with him from one of the northern of the Kurile Islands, and the evidence he is thus able to give in regard to the identity of the inhabitants of the Kurile Islands and those of Yesso, and to the similarity of their dialects, is very conclusive. He says: "The language of the inhabitants of all the Kurile Islands, except some tribes on the south part of Matsmai, is alike, with the exception of such words and the names of such things as the northern Kuriles first got from the Russians, and those of the south from the Japanese. Alexi (the Aino mentioned above), though he had difficulty in understanding them, yet it never happened that he did not comprehend them after some explanation; in a word, the languages of the inhabitants of Matsmai (another name for Yesso) and of the other Kurile Islands resemble each other much more than the Russian and Polish. The Kuriles of all the islands and Yesso call themselves Ainu (better Aino); but to distinguish the inhabitants of the different islands, including Matsmai, they add to every word the name of the island, as for example, Kunashir-Ainu, Iturup-Ainu, that is, the people of Kunashir, and the people of Iturup. When they see

foreigners they call them Rusko, Russians, or Niponno, Japanese, as they know only these two nations." The only difference between the Ainos of Yesso and the Kuriles is, that the former are "handsomer, stronger, and more active" than the latter, and this difference Golovnin thinks is due to the former leading a more active life, and having a greater abundance of good food. "The northern Kuriles live in indigence, feed on roots, sea animals, and wild fowls, of which indeed they never want, but idleness often hinders them from collecting a proper stock."

To show how uniform are the customs of this people over Yesso, we may quote the following description of the Ainos at Romanazoff Bay, at the northern end of the island, near La Pérouse Strait, from Krusenstern's voyages: "We saw there only two fur dresses, and the rest of the people were dressed in a coarse yellow stuff made of the bark of a tree, which a few bordered with blue cloth. (In the cloth I saw them weaving at Volcano Bay they occasionally placed a few threads of blue cotton so as to give the whole a striped or checked appearance.) "Under this dress they had another of a fine cotton stuff that they had probably purchased from the Japanese. The Ainos of Yesso (which was at that time under the Japanese) were much poorer than those of Saghalien (which, a short time before, had become a part of the Japanese Empire). The women wore no ornaments on their heads, but as I have already mentioned, they invariably paint their lips blue. The men wore earrings, which were commonly merely a brass ring. At this place we visited two abodes which consisted of a single large room, which, with a small division at one end, occupied the whole interior of the house. Their construction did not seem to me very solid, and I cannot conceive how they are able to bear the cold, which must be very intense here in winter. In the middle of the room was a large hearth, around which the whole family, consisting of eight or ten persons, was seated. The furniture consisted of a large bed, over which a Japanese mat was spread, and several boxes and barrels. All their utensils were of Japanese manufacture, and mostly lacquered: it appeared from the interior of the house that the inhabitants possessed a degree of affluence, such as is not found among the Kamtschadales, still less among the Aleuti and the unfortunate inhabitants of Kodiack. Fish is probably their only nourishment, their houses on this account being chiefly scattered along the shores. We perceived no symptoms of cultivation, not even any plantations of vegetables, nor did we see any tame fowls or domestic animals, except dogs, which they had in great abundance."

The first full description of the features of this people was given by M. Rollin in La Pérouse's voyage in 1787, and as it seems to be what has been constantly copied by all ethnologists, I give a translation in full. The natives described were seen at the bay of Langle, on the west coast of Saghalien. "These people are very intelligent, respect property, and communicate freely with strangers. They are of moderate height, short, strongly built, have a *léger embonpoint*, and the forms of the muscles very marked. The most common height is five feet. The tallest are five feet four inches, but such men are very rare. They have large heads, and a large face more rounded than that of Europeans. Their countenances are animated, quite agreeable, although all the parts that compose the face do not have in general the regularity of ours. Nearly all have the cheeks large, the nose short and rounded at its extremity, and the nostrils very thick; the eyes sparkling and *bien fendus*, of medium size, sometimes blue but generally black; the eyebrows heavy; the mouth medium; the voice strong; the lips somewhat thick and of a dark color. Some individuals have the upper lip tattooed with blue; these parts, also their eyes, are capable of expressing every kind of sentiment. They have beautiful teeth, very regular, and of the ordinary number, the chin rounded and slightly salient, the ears small; these they pierce in the lower part, and wear ornaments of glass or silver rings."

Although this description of their features is certainly the most complete and the most accurate that I have been able to find in any work, yet it fails to mention their two most important characters, already noticed in my previous paper, to wit: first, that their eyelids are *horizontal* and open *widely*, and are not *oblique* and open but *partially*, as in all the Mongol family; and secondly, that their cheek bones are *not* prominent. These two great characters, which are constant except in the descendants of those Japanese officials who take concubines from the Aino women, in my opinion, separate them from the whole Turanian family, where, so far as I am aware, every ethnologist has placed them, without adding even the slightest hint that their true position was in any degree doubtful.

These same characters show that hereafter they must be regarded as a branch of *our own Aryan family*.* This view is strengthened by the wonderful development of their hair, which has generally been given as their most important char-

* Dr. Pickering, Curator in the Ethnological Department in the Society and Ethnologist on the U. S. Exploring Expedition, fully concurs with the view expressed above, and authorizes the addition of this note.

acteristic. In this they agree with the bearded peasants of Russia, and approach the Slavonian branch of the Indo-European division of the Aryan family. Their nostrils are somewhat thick, but the nose is much more prominent than in any branch of the North Turanian family at least. This last character is not fully shown in the accompanying photographs, as they do not represent the head in profile.

Latham, in the latest edition of his careful and extensive work, "Descriptive Ethnology," published in 1858, refers both the Ainos and Gilaks (Gilyaks) to one sub-group of the Turanian family, "the Kurilians." He further adds: "Mongol features are common, yet prominent noses and comparatively thick beards are by no means rare." The first character is true of all the Gilyaks, who are probably more nearly allied to the Kamtschadales, the Koriaks, the Tchuktchis and the Yukahiri, than they are to the neighboring Tungusic tribes on the Amoor. All these peoples are of pure Mongolian stock. The second and third characters mentioned by Mr. Latham, instead of being "by no means rare," are universally found among all the Ainos, whether those living on the Kurile Islands, on Yesso, or on Saghalien.

Von Siebold, who lived many years in Japan, and who enjoyed the best of opportunities for studying this people, in one of his last works, "Elucidations to the discoveries of Vries," London, 1859, speaks of this isolated and distinct people as "the Aino *tribe*," as if, instead of belonging to a different grand division of the human family, they merely formed but one of the many Turanian tribes in the northeastern parts of Asia, though widely separated from them.*

Even Mr. Pauly, in his great work published at Moscow, in celebration of the crowning of the present Czar of Russia, in 1855, refers them to a subdivision of the Turanian family, and includes in that subdivision the Gilyaks, the Kamtschadales, etc.

Not only do these people differ from all the Turanians in their *physique*, but in all their mental characteristics. Instead of being reserved and wily, like all the peoples of the Mongolian stock, they are most open-hearted and communicative. Instead of being of a roving character, they appear attached to their own country. Their mild and generous dispositions have been especially noticed by every European who has ever seen them. Capt. Krusenstern thus minutely and graphically describes these characteristics: "Here (i. e. within their dwellings) was no loud talking, no immoderate laughter,

* When the previous article was written I had not seen this view of Von Siebold.

and still less any disputing. The satisfaction that appeared in all their countenances as they spread their mats round the hearth for us; their readiness, when we were going away, to launch their canoes and carry us across the shallows to our boat, when they perceived our men stripping themselves for this purpose; but still more than this, their modesty never to demand anything, and even to accept with hesitation whatever we offered them,—wherein they differ very much from the inhabitants of the west of Saghalien (that is, from the Gilyaks),— these marks of their natural character make me consider the Ainos as the *best of all the people I have hitherto been acquainted with.*"

The view herein expressed, that they form a member of our own family of nations, renders their language perhaps the most interesting of any that now remains uninvestigated, in the whole world. All that is known at present regarding it may be well summed up in these words of Von Siebold:

"The Japanese, who have had intercourse with the natives of Yesso for centuries, carried on trade with them, and ruled over them, have gradually made themselves thoroughly acquainted with their language, and composed dictionaries in which they sought to render as faithfully as possible, and to fix the pronunciation of the words by means of their syllable writing. In this manner they have endeavored, by means of writing, to put a stop to the manifold sounds and variable accent to which the dialect of a far dispersed and illiterate people is so subject." (This dictionary referred to was published in Japan in 1804, by Mogami Yoknai.)

"Although the Aino language has become ennobled by familiar intercourse with a civilized people (the Japanese), yet it has preserved its original features, and is characterized as a peculiar and independent language, having no connection with that of any of the neighboring countries, as far as regards the roots of the words. That some foreign words have been introduced from the northwest and northern nations (*Samoiedes, Tungus* and *Kamtschadales*) with whom the Ainos had intercourse, is not to be denied, any more than that they have naturalized many Japanese words, signifying objects and ideas formerly unknown to them. The Aino language, as the tribe itself, stands isolated from all the others of the northeast of Asia, for so far as they are yet known." This last sentence, so far from hinting that their nearest allies are to be found in Europe or Persia or Hindustan, at once suggests—if it contains any suggestion—that their nearest allies live in the southeastern parts of Asia. He continues: "The general rules, however, according to which the parts of speech are de-

clined and conjugated, agree with those of their southern, northern and western neighbors, who write their language *syllabically* (as the Manchus, Mongols, Tibetans, Yakuts, etc.) and not *figuratively*, that is to say, using signs for words (as the Chinese)."

Here, then, we have an *Aryan* people speaking a *non-Aryan* language, and that language peculiarly their own; not learned from a people who have subjugated them, or from a people whom they have subjugated, at least within two thousand five hundred years!

At the close of the preceding paper I suggested, in the form of a question, that these people had migrated in the most ancient times from Central Asia. The fact that there is some reason to suppose that as early as 2,000 years before Christ there was "a settled government and society" in China, afterward suggested that this migration took place along the northern borders of the Mongolian desert, or the southern parts of Siberia, to the head-waters of the Amoor, and thence either down the Amoor to the island of Saghalien, or down the peninsula of Corea to the Japanese islands, or possibly in both of these directions, because the migrating stream of such a weak and undeveloped people as the Ainos now are and probably were at that time, would have been turned aside by a settled government as easily as a huge boulder turns aside a mountain brook. This view I now find has already been suggested by Von Siebold.

Professor Max Müller, judging from the evidence of grammatical structure, supposes there have been three great migrations from Central Asia toward the northern and northeastern parts of the continent. They are as follows: firstly, the ancestors of the present *Tungus*, along the Amoor and the Lena; secondly, the ancestors of the *Mongols*, in the region of the Altai mountains; and thirdly, the ancestors of the *Turks*, including the *Yakuts*.

In a similar manner, but perhaps centuries before the first of these three migrations, we may suppose the Ainos to have separated from the rest of the Aryan family and to have moved on toward the east till they reached the islands of Japan. The early date of this migration is indicated by the negative evidence, that as far as we are yet aware these people are not mentioned by the ancient historians of China as being ever found on the continent. The earliest notice of them appears "in the Han dynasty * (between 189 B. C. and 30 A D.), when the *Mao-mim*, whose bodies were covered with

* Von Siebold's Eluc. to Vries' Voyage, p. 122.

hair, are described as inhabiting *the other side* of the East Sea." This East Sea was probably the one we now call the sea of Japan. During the *Sui* dynasty (A. D. 608–622) a notice occurs of "the tribe *Mo-zin*, consisting of fifty hordes, living in the northwest of the land, Woke (Japan)."

That none of these people lived in the territories immediately tributary to China, in those early times, is proved by the fact, that in A. D. 659, the Japanese on one of their embassies to the court of that great empire took two Ainos with them to exhibit as *curiosities*.

This people are undoubtedly passing away. Even during the last century and a half that the northern of the Kurile chain has been a part of the Russian empire, their numbers on those islands have been ascertained to have greatly diminished, though the Russians have unquestionably treated such obedient subjects with the greatest kindness. The causes of this decrease are supposed to have been the ravages of the small pox, and the considerable numbers lost while crossing from island to island in their frail boats over those stormy seas.

On Yesso and Saghalien, where they have for several centuries continued under the merciless tyranny of the Japanese government, their numbers have probably diminished in still greater proportion. At Kusyunai, on the latter island, I was assured by a Russian officer that when some Ainos came there to escape from the Japanese and place themselves under the protection of the Russian government, and the official stationed there had refused to receive them for fear of complicating the two governments and had sent them back, the Japanese government "beheaded them to a man." A great diminution in their population must also have followed their forced removal from the large and fertile island of Japan to the comparatively sterile island of Yesso, and to the yet more rigorous climate of the Kuriles. Indeed, there is much reason to believe that if the enlightened nations of the western world had been a few centuries later in reaching that distant region of the east, these people would only have been known to us by a few passages in the writings of the Japanese historians, and even then all such references would probably have been regarded by careful investigators as apocryphal, and more properly classed with myths and fables.

Though they were, long ago, mostly subjugated by the Japanese, yet the tribes in the interior of Yesso continue independent down to the present time, and here, far removed from any influence of the Gilyaks, Kamtschadales and Russians on the north, the Manchus on the west, and the Japanese on the south, we may expect to find these people still retaining all the ideas of their ancestors, and practicing all their ancient customs.

ART. XL. — *On the existence of the Mastodon in the deep-lying gold placers of California;* by B. SILLIMAN.

DURING several visits to the gold regions of Tuolumne county, California, in the summer of 1867, I obtained evidence leading to the conclusion that the Mastodon, and perhaps the Elephant, existed prior to the great volcanic disturbances and outpourings of lava which occurred throughout the Sierra Nevada mountains pending or at the close of the epoch in which the deep-lying placers were produced.*

It is well known that this epoch of volcanic activity has been regarded as marking the period of the Pliocene, dividing it from the Post-Pliocene and existing epoch, by a well-marked horizon. Among the animals whose remains have been found in this ancient auriferous detritus of California, preceding the epoch of volcanic activity, are "the rhinoceros, an animal allied to the hippopotamus, an extinct species of horse, and a species allied to the camel and resembling the *Megalomeryx* of Liedy."†

The remains of mastodon and elephant are found abundantly in the superficial detritus of the gold region, over an extended area, but until now they have never been certainly idenfied as occurring under the basalt, which covers the ancient gold drift and forms the highly characteristic ranges known as "Table Mountains."

Near Jamestown, a village in Tuolumne county, extensive explorations have been made during the past fourteen years, in the deep-lying gold detritus, by tunnels driven in beneath the basaltic capping, at a level low enough to open the bed of the ancient rivers, in the channels of which rests the gold-bearing gravel. These tunnels are from a few hundred feet in length to three thousand feet or more ("New York tunnel" 3,500 feet), and they are from two hundred to three hundred feet below the nearly level surface of the basalt. They are driven as nearly as possible at right angles to the supposed course of the ancient stream, and in order to drain off the water by gravity, the grade commences often 150 feet or more beneath the lip of the "rim rock" or margin of the old valley, aiming to come out in, or just beneath, the ancient channel or river bed. Underneath the basalt is a mass of stratified, almost horizontal, generally thin-bedded, detrital matter, alternating with clay and argillaceous zones, the thinly laminated beds containing often veget-

* For a notice of the nature of these remarkable deposits, see a paper by the author, in this Journal for July, 1865 [II], xl.

† Geological survey of California, vol. I. (Geology) p. 251.

able stems and impressions of leaves, indicating deposition in quiet water, while other portions are made up of coarse gravelly masses, compacted often into firm coherent "cement," as the miners call it. From the ancient river bed to the top of the basaltic capping of Table Mountain, is certainly not less than three hundred feet, probably somewhat more.

It is beneath this mass of matter, partly aqueous and partly volcanic in its origin, that the remains of mastodon herein mentioned have been found. My attention was first called to them by discovering the portion of an *os illium* in the collection of A. B. Preston, Esq., local Judge of Jamestown, which he assured me had been found in driving the so-called Humbug Tunnel under Table Mountain, at a point 1,500 feet in from its mouth. Associated with it was the point of a tusk, which I also secured. Both these specimens are now in the collection of the Peabody Museum at Yale. Although I obtained the the plainest possible testimony of eye witnesses to the fact that these bones were taken from beneath the basalt, I should not venture to mention the fact in support of the opinion that the mastodon existed in the Pliocene period, without farther and more satisfactory evidence.

This I was fortunate enough to obtain from Mr. D. T. Hughes, now engaged in exploring a tunnel upon the southwest side of the same mountain, which was formerly known as the Maine Boy's Tunnel,* but now called after Mr. Hughes. Mr. H. informed me, that at a point about 1,600 feet in the tunnel named, bones existed, believed by him to be those of mastodon or elephant, and which had been uncovered some time since, but were at the time of my visit inaccessible, owing to the falling in of that portion of the work. I immediately visited the place, and made all the examination possible at the time, but could not then nor on a later occasion gain access to the bones. At my request explorations were resumed in the direction likely to uncover them, and I made arrangements to return to the locality whenever the miners should again reach these interesting remains, but up to the date of my leaving California (January, 1868), I was advised that this point had not yet been reached, and all I could do was to urge Mr. Hughes to use all diligence in the search and communicate to me by letter a full notice of the facts as they should develop themselves. On the 24th of March I had the pleasure of receiving from him the following letter.

* For a section of the Maine Boy's Tunnel see Geological survey of California, Geology, vol. i, p. 249, where also, pp. 243–253, may be found a fuller account of the Table Mountain and accompanying phenomena, than our space permits us to give herewith.

Letter from D. T. Hughes to B. Silliman, dated Jeffersonville, February 22, 1868.

"In compliance with your desire that I should write to you whenever I should reach the bones, I have now to state that I have reached them at last, and I regret very much that you were not here to examine them as they lay. The bones were very much decayed, indeed so much so that I found it impossible to obtain any of them whole, with the exception of four grinders, which I have in a very good state of preservation. The remains of this large animal were found 1,650 feet in under the Table Mountain, and four and a half feet above the ledge or bottom slate, imbedded in a stratum of sand overlaying a deposit of gold-bearing gravel, and scattered over a space twenty feet long by ten or twelve feet wide. A large portion of these bones were so soft that I could penetrate right into them with my fingers, while other pieces were a little harder, and looked very interesting. Some of the cavities were lined with yellow iron pyrites, and so bright, that when first exposed to the light of the candles, they glitter like diamonds. I have numerous fragments of different bones which bear handling very well when thoroughly dried. The two tusks lay together, imbedded in the same stratum of sand, and very much decayed also. I endeavored to remove them entire, or in medium sized pieces, so that I could put them together again, but I was unsuccessful and found nothing that would hold them together. Both of the tusks were slightly curved, and large pieces of the points had been broken off, apparently. Each tusk measured, as I found them, seven feet and one inch in length, and if whole would probably have measured ten feet. They were not exactly round, measuring three feet from the end that enters the socket six inches in one diameter and five and a quarter inches in the other.

The grinders, as before mentioned, are in a very good state of preservation. The two posterior grinders each measure six inches in length and three and a half inches wide, and the two exterior measure each four and a half inches in length and two and three-fourths inches wide. The enamel on the posterior ones is very perfect, but the exterior grinders are very much worn, apparently. I found it impossible, because of their softness, to get the dimensions of any of the other bones, which I regretted very much.

Enclosed you will find a rough sketch of three of the teeth (with portions of the jaw attached.) The two grinders you see togther are in the same position as when I dug them out. The sketches are not drawn to an exact scale, but will convey an idea of the grinders as they are. The other drawing is the side view of the posterior grinder. * * * *

From Mr. Hughes' description and the accompanying drawings there is no room to doubt that the bones discovered are those of the mastodon, and it appears probable that nearly the entire skeleton of a full sized animal was entombed in the sands resting immediately upon the ancient auriferous gravel beneath

the Table Mountains, and of course anterior in age to the period of volcanic activity and overflows of lava, which have hitherto been considered as marking the close of the Pliocene era, a catastrophe which appears to have exterminated the other members of the Pliocene fauna.

If the mastodon survived the catastrophe which exterminated the hippopotamus, rhinoceros, tapir, &c., and continued through the Post Pliocene, to the appearance of man, it yet remains to be proved that man was his companion prior to the dawn of the existing epoch.

New Haven, March 25, 1868.

ART. XLI.—*Note upon the occurrence of fossil remains of the Tapir in California;* by WM. P. BLAKE.

The remains of Tapir occur in the auriferous gravel of Wood's creek, near Sonora in Tuolumne county, California. They were found by gold miners at a depth of about forty feet below the surface, and were presented to me by Dr. Snell of Sonora. A specimen submitted to Prof. Owen at the British Museum was recognized as the "crown of the left lower molar tooth of a tapir, and another specimen as the posterior epiphysis of the cervical vertebra of a hoofed animal, probably a young tapir." Numerous teeth of the Mastodon have been found in the same region, together with stone implements of various forms. Some of the latter, according to the statements of Dr. Snell, were taken from the deep placer deposits which underlie the lava of Table Mountain.

ART. XLII.—*Nitroglucose;* by M. CAREY LEA.

As nitroglucose has been much less studied than its congeneric nitro-substitution compounds pyroxyline, xyloidine and nitroglycerine, a few words on its preparation and properties may not be uninteresting.

The substitution does not take place in sugar with quite the same facility as with cellulose; the acids need to be stronger and the temperature lower. The sugar, moreover, appears at first to dissolve, and then to separate out again, in the form of a greyish paste, which, when thrown into water and freed from the adhering acid, becomes nearly white.

An attempt to prepare nitroglucose by the use of nitre and sulphuric acid, which succeeds so well and so easily in the case

of cellulose, failed almost wholly with sugar. Not more than two or three per cent of the weight of the sugar was obtained.

With sulphuric and strong nitric acids, allowed to cool thoroughly after mixing, the reaction takes place easily, and a considerable quantity of nitroglucose is obtained. The nitric acid should be as strong as possible, and as the acid of the requisite strength is not easily obtained commercially, I have found an advantage in using in part the fuming sulphuric acid. Two fluid ounces of fuming sulphuric acid, two of common sulphuric, two of strong nitric acid, as near to 1·5 sp. gr. as can be obtained, give good results. The sugar is stirred in, in the form of powder, to a thin paste. The stirring is kept up, and as fast as the nitroglucose separates in doughy masses, it is removed with a spatula and thrown into cold water. A further addition of sugar will give more nitroglucose, but considerably less in proportion than the first addition. As soon as possible, the nitroglucose is to be kneaded up with cold water, to get the acid out. In one case, when this was neglected for ten or fifteen minutes, the nitroglucose passed to a greenish color and apparently was undergoing a commencing decomposition.

The removal of the adhering acid is much more difficult than in the case of pyroxylin, and is an extremely disagreeable operation. The acid pervades the whole of the doughy mass so fully, that the fingers are stained and burned by it, nor can the whole of the acid be removed satisfactorily in this way. The best means I found was to dissolve the crude nitroglucose in a mixture of alcohol and ether, and then to pour this into a large quantity of cold water with constant stirring, and violent agitation afterward. The method is not altogether satisfactory, and seems to be attended with some loss of material, though why, it is not easy to see.

Prepared in this way, nitroglucose is a white lustrous body, which may either assume the doughy amorphous condition or the crystalline, and passes from one to the other with extreme ease. When first formed by the mixed acids, it always has the doughy form. That which I obtained by the use of nitric and sulphuric acid, was crystalline from the first. When precipitated by water from its solution in alcohol and ether, it is doughy and almost liquid, and remains so for a long time, if there is any considerable quantity of it.

The best mode of preserving it appears to be under water. By standing thus it gradually hardens, and passes sometimes to a somewhat hard amorphous mass, and sometimes to a granular crystalline state. It appears to be wholly insoluble in water. A few minute grains of the crystalline form diffused

through 15 or 20 ounces of water, did not dissolve after many hours standing. In a mixture of alcohol and ether it dissolves as easily as sugar in water, and in such quantity as to make the liquid syrupy.

Its detonating properties are but slight. If it be well dried and a match be applied, it deflagrates with a feeble flash.

It has been stated by Dr. V. Monckhover, that when dissolved in alcohol and kept sometime in a warm place, it undergoes decomposition, as evidenced by the fact that the solution then gives an abundant precipitate with nitrate of silver, which at first it did not do. An experiment made in this direction did not give the result thus indicated. A solution of nitroglucose in alcohol, containing about 40 grains to the ounce, was placed in a stoppered vial and was kept in the sand bath at a temperature of about blood heat for nearly a month. But neither it nor a fresh solution gave a precipitate with alcoholic solution of nitrate of silver. It would seem from this that certain conditions of temperature or otherwise are necessary, in order that this decomposition should take place.

ART. XLIII.—*On the action of Ferrocyanid of Potassium on Monochloracetic ether*; by O. LOEW, assistant in the Laboratory of the College of the City of New York.

KOLBE was the first to prepare cyanacetic acid, which is especially interesting from its transformation into malonic acid by treatment with potassa. In a similar manner Heintz prepared sulphocyanacetic acid, by boiling monochloracetic ether with sulphocyanid of potassium. This led me to try the action of ferrocyanid of potassium upon monochloracetic ether, to ascertain whether the radical ferrocyanogen can participate, as such, in the reaction. I boiled monochloracetic ether, dissolved in alcohol of 90 per cent, with powdered ferrocyanid of potassium for 4 to 6 hours. An action gradually took place, by which chlorid of potassium was formed, together with another light blue amorphous substance, which became of darker color on exposure to the air, and was undoubtedly Prussian blue.

When the liquid was filtered and boiled with caustic potassa, ammonia was developed; after the latter ceased to be evolved, the liquid was mixed with sulphuric acid and agitated with ether. On evaporating the ether I obtained white crystals, having the appearance of malonic acid. This substance was converted into the lead salt by precipitation with acetate of lead: 0·2997 grm. yielded 0·2904 grm. sulphate of lead = 66·99 per cent Pb. The malonate of lead contains 66·99 per cent Pb.

The reaction is therefore not analogous to that above cited, but the radical ferrocyanogen is broken up into cyanid of potassium and cyanid of iron. The former yields, with chloracetic ether, chlorid of potassium and cyanacetic ether, while from the last named body malonic acid is produced.

New York, Nov. 26, 1867.

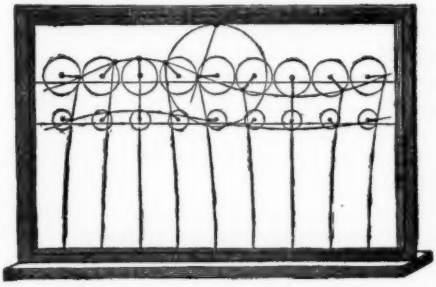
Art. XLIV.—*On C. S. Lyman's new form of Wave apparatus.*

The theory of waves that has been generally taught since the days of Newton, is that which represents wave motion as consisting in the alternate rising and falling of the parts of a liquid in vertical lines, as in the two branches of a U-shaped tube; this is usually cited as Newton's theory of waves. There is to be found, indeed, in the *Principia*, the hypothesis of vertical oscillations, and also the cut of the bent tube, so persistently copied by subsequent writers; yet, it is evident that Newton adopted the hypothesis, rather as an expedient for a special purpose—that of finding approximately the relation of a wave's length to its period—than as strictly true to Nature; for he concludes his investigation with the remark:—"These things are true, upon the supposition that the parts of water ascend or descend in a right line; but, in truth, that ascent and descent is rather *performed in a circle* ("*verius fit per circulum*"); and therefore I propose the time defined by this Proposition as only near the truth." This important qualifying clause seems to have been quite overlooked by those who have professed to give Newton's theory of waves.

The modern theory—which teaches that, in wave motion, all the particles of a liquid are revolving synchronously in vertical circles—though so broadly hinted at by Newton himself as the true one, in the words italicised above, has nevertheless been developed, for the most part, only within the present century. It was first clearly stated and ably advocated by Gerstner in 1804. More recently, it has been satisfactorily established as accordant with observed facts and the laws of Mechanics, by the experimental researches of Weber and Scott Russell, and the mathematical investigations of Stokes, Rankine, and others. A concise exposition and demonstration of the theory may be found in a paper by Prof. Rankine, in the Philosophical Transactions for 1863. Though but just beginning to find its way sparingly into the text books, it has become the generally accepted theory among men of science; and having in reality supplanted the old hypothesis as an expression of scientific truth, there is no good reason why it should not also supplant it, in the lecture and recitation room.

In teaching this theory, however, it is often found difficult to make pupils understand, how the infinitude of simultaneous revolutions, which it supposes, can take place without mutual interference, and in such a way as to produce the observed phenomena. It was to obviate this difficulty, and illustrate, as far as practicable, the *modus operandi* in question, that the piece of mechanism was devised, which is the subject of this article. It presents to the eye, not merely the surface contour of a wave, with its undulatory motion—which, to some extent, other forms of wave apparatus also do—but, besides doing this in a more exact and satisfactory manner, it exhibits the motions also that are at the same time taking place below the surface, in the whole mass of liquid affected. This completeness of illustration is due to the circumstance, that in the apparatus, the elementary motions are the same, essentially, as in actual waves; hence, the leading points, geometrical and dynamical, of the theory of waves, are presented naturally, and in their true relations.

The construction of the apparatus will be readily understood from a brief description, and the accompanying cut.



In front of a plane surface are two series of revolving arms or cranks, the length of the lower ones being half that of the upper. Two elastic wires connect the crank-pins of each series; upright wires also connect each pair of cranks, and pass down through a plate into the base. The cranks all revolve synchronously; they thus keep their relative position, and come into any given position successively, each in its turn. The relative position of the cranks of each horizontal series is such, that the directions of any two, in regular order, differ by the same fraction of a whole revolution, that the distance between their axes is of a whole wave length. Thus, in the apparatus, the wave length is supposed to be divided into eight equal parts, and hence the common difference between the directions

of adjacent crank arms is one eighth of a circle, as shown in the figure. The cranks in each vertical set have their positions always alike. The number of cranks, whether taken horizontally or vertically, is arbitrary—a matter of convenience in construction. The synchronous revolution of the cranks is effected by means of any suitable mechanism; such as, equal toothed wheels on the several axes, with alternate idle wheels connecting them; or, equal rag-wheels, with endless chain, or metallic ribon; or, equal cranks, with a rigid connecting frame, or plate. The first method is used in the original machine, the third in the model for the Patent Office, the second and third in the larger and smaller sizes, respectively, for the market.

The crank pins represent as many liquid particles; the circles on the background their orbits. The transverse wires represent continuous lines of particles, which at rest would be horizontal, and be represented by the lines on the background drawn just below the centers of the orbits; the upper one of these being the surface line, the lower a line of particles one ninth of a wave's length down. The upright wires represent lines of particles which at rest would be vertical. Every point in these moving lines describes its own distinct orbit.

The apparatus is constructed to a scale; and so, represents a wave of given length, height, and period; but equally represents, also, a wave of any other length and proportionate height, though of period proper to its length, according to the law of that relation, as stated farther on. In the original instrument, for example, the wave length is 36 inches; height, from trough to crest, 4 inches; and period, for that length, $0^{s}{\cdot}76$; but it equally represents a wave whose length is 36 feet and height 4 feet, with period $2^{s}{\cdot}63$; and similarly, for other proportional dimensions.

Among the particular points, in wave phenomena, which are elucidated by this apparatus, may be enumerated the following:

1. *The undulating surface-profile.* This is shown in the motion of the upper flexible wire, which presents a continuous contour line, of the exact curvature, throughout, of a true normal wave; instead of a broken contour, of arbitrary form, by means of rising and falling balls, as in the ordinary wave apparatus.

2. *The undulatory motion of all sub-profiles, or lines of equal pressure, down to still water.* The representative of such lines is the lower transverse wire, which moves similarly to the upper one, but with a less curvature. Every such line of equal pressure is a continuous one, composed of particles in a state of dynamical equilibrium, and constituting an ideal moving wave, exactly as if at the surface—the corresponding phases of all such waves being on vertical lines.

3. *The genesis of the undulatory motion from the circular motion of revolution.* This is seen in the mode in which the crank-pins, in each transverse series, or the particles which they represent, come in regular succession into a given position, as they revolve synchronously in their orbits.

4. *The equality of the height of a wave, from trough to crest, with the diameter of the orbits of the surface particles.* This is obvious in the apparatus, and follows directly from the mode in which the wave surface is generated.

5. *The direction of motion of particles of water in the different phases of a wave.* A glance at the motion of the crank pins, shows that a particle at the wave's crest is moving forward, or in the direction in which the wave is propagated, and a particle at the trough in the reverse direction, or backward; that a particle on the forward slope is rising, and one on the back slope descending. The same is true of particles in all the sub-waves, or surfaces of equal pressure, down to still water.

6. *The length of a pendulum keeping time with the wave.* This is equal to the radius of a circle whose circumference is the wave's length. Such a circle is the large one drawn on the background, as shown in the figure. Its radius is to that of a particle's orbit (or length of a crank arm), as the particle's weight is to its centrifugal force. Or, putting R and r for these radii respectively, and t for the time of revolution, we make

$$\mathrm{R} : r :: g : \frac{4\pi^2 r}{t^2};$$

Whence

$$t = 2\pi\sqrt{\frac{\mathrm{R}}{g}};$$

which is the period of a revolving pendulum, or the time of a double oscillation of a simple pendulum, whose height is R. Compare (10).

7. *The dependence of a wave's period on its length alone—not on its height.* This is a corollary from the preceding. The period varies as the square root of the length, and is the same for all sub-waves, as for the surface wave—the length being the same for all. The height, within certain limits, is independent of the length, as appears in the apparatus, and as may be inferred from the formulæ given farther on. It depends on the centrifugal force of the particle, and this, ultimately, on the external forces generating it.

8. *The varying direction and intensity of the resultant force acting, at each instant, on a given particle in a wave.* The component forces are two—the particle's gravity, and its centrifugal force. The former is represented by the vertical radius of the large circle, the latter by the radius vector of the revolv-

ing particle; their resultant, then, is represented by the third side of the triangle of forces, or the side formed by the wire pendulum. This resultant must be always normal to the wave surface, as the wire pendulum is seen to be always at right angles to the elastic wire representing that surface.

9. *The condition of a wave's rupture at the crest.* When the centrifugal force becomes equal to gravity (or the radius of the orbit to that of the large circle), the resultant force, for a particle at the highest point of its orbit, or crest of the wave, must be zero, and the particle consequently fly from its orbit, or the crest break in foam.

10. *The trochoidal form of the wave curve.* The point of suspension of the pendulum, that is, the upper extremity of the vertical radius of the large circle, may be regarded as the instantaneous center about which an element of the wave curve at the point of normalcy of the pendulum is described. Consequently, if this circle be rolled under a horizontal straight line, a point within it distant half the height of a wave from the center, will trace the wave profile; which therefore is a trochoid. The rolling circle is the same for all wave profiles, down to still water, the lengths of the tracing arm only differing. The circumference of this circle equals, of course, the wave's length.

11. *The greater sharpness of the crests than of the troughs of waves.* This follows from the preceding, and is shown in the relative positions of the crank-pins—nearer together at the crests, farther apart in the troughs. The trochoids become, necessarily, sharper at the upper bend, and less so at the lower, as the tracing-arm approaches to an equality with the radius of the rolling circle; until, when that equality occurs, the trochoid passes into the cycloid, which has sharp cusps. The cusp of the inverted cycloid, then, is the limit of sharpness of a wave's crest. The equality above named is equivalent to that of the centrifugal force of a particle with its gravity (9). When the latter condition occurs, the wave curve is cycloidal, and only then.

12. *The limits of possible curvature of waves.* That curvature must always lie between the cycloid at the one extreme, and the straight line at the other—embracing trochoids of every possible variety.

13. *The greater elevation of the crests above the level of still water, than depression of the troughs below it.* The difference between this elevation and depression is equal to twice the height due to the orbital velocity of the particles, that is, to twice the height from which a body must fall to acquire that velocity; or, is a third proportional to the radius of the rolling

circle and that of the particle's orbit; that is, putting R and r for these radii respectively, v for the orbital velocity, $\left(=\frac{2\pi r}{t}\right)$, and D for the difference in question,

$$D=\frac{r^2}{R}=\frac{v^2}{g}.$$

When r equals R, then $D=r$, or half the height of the wave.

14. *The elevation of the centers of the orbits of particles above the positions of the same particles at rest.* This is shown in the distance of the axes above the corresponding lines on the background. These lines show the positions of lines of particles at rest, which, in motion, form the wave profiles represented by the transverse wires. The elevation in question is equal to the height due to the particle's orbital velocity; or, is a third proportional to the diameter of the rolling circle and the radius of the orbit; or, is equal to the area of the orbit divided by the length of the wave; that is, putting H for this elevation, l for the wave's length, and the other symbols as before,

$$H=\frac{r^2}{2R}=\frac{v^2}{2g}=\frac{\pi r^2}{l}.$$

When r equals R, $H=\frac{r}{2}$, or one-fourth the height of the wave. To this elevation is due one half the mechanical energy of a wave—the other half to the motion of its particles. That energy is, in other words, half potential, half actual.

15. *The decreasing diameter of the orbits with depth.* This is seen in the shorter crank-arms below, and the decreasing amplitude of sway of the upright elastic wires, down to their points of rest, which mark the depth of still water. The decrease of the orbits in diameter takes place in a geometrical ratio, and is approximately one half for each increase of depth equal to one ninth of a wave length; or, more exactly, putting r and r' for the radii, respectively, of a surface orbit and of one whose middle depth is k, it is $r'=re^{-\frac{k}{R}}$,
R being, as before, the radius of the rolling circle, and e the base of the Naperian logarithms.

16. *The peculiar swaying motion of continuous lines of particles of equal pressure, which at rest are vertical.* These lines are alternately lengthened and shortened, and bent to right and left, as represented by the upright elastic wires.

17. *The varying distortions undergone by blocks or sections of water originally rectangular, or rectangular when at rest.* Such sections are represented by the spaces between the wires, and their distortions by the distortions of these spaces.

18. *The fact of sensibly still water at half a wave's length below the surface.* This is exhibited in the absence of lateral motion at the lower extremities of the upright wires, and is a necessary result of the law of diminution of orbits with depth, as given above (13).

19. *The varying strain, in wave action, on floating bodies.* This is seen in the varying angle made by the upright wires with the upper transverse wire; the latter shows the position of a raft, for example, lying on the wave surface; the former, that of a long, thin body, as a board, floating end down; hence, the varying relative direction of the wires shows the strain to which a body is subjected, having both breadth and depth, as the hull of a vessel.

Many other points, besides the above, may be studied to advantage in connection with this apparatus, but it is not important to specify them here. Enough have been stated to illustrate its utility, and indicate in what respects it differs from every other form of wave apparatus.

For convenience of reference, and for the sake of completeness, a few formulæ are added, expressing other relations among wave phenomena, not so directly exhibited by the instrument, but important to be presented in connection with it. Putting V for the velocity of propagation of a wave, and the other symbols as before, the length of the wave is

$$l = 2\pi R = \frac{gt^2}{2\pi} = \frac{2\pi V^2}{g} = tV;$$

its period

$$t = \sqrt{\frac{2\pi l}{g}} = 2\pi\sqrt{\frac{R}{g}} = \frac{l}{V};$$

the velocity of a particle in its orbit, or at the crest of the wave,

$$v = \frac{2\pi r}{t} = r\sqrt{\frac{g}{R}} = r\sqrt{\frac{2\pi g}{l}} = \frac{Vr}{R} = \frac{2\pi rV}{l} = \frac{gr}{V} = \frac{tgr}{l};$$

the velocity of propagation of the wave

$$V = \frac{l}{t} = \frac{gt}{2\pi} = \sqrt{\frac{gl}{2\pi}} = \sqrt{gR} = \frac{gr}{v};$$

the sine of the angle of steepest slope of surface is

$$\sin\theta = \frac{2\pi r}{l} = \frac{r}{R}.$$

It will be understood that the normal wave, to which the theory applies, and which the apparatus illustrates, is the wave on deep water, or water a wave's length, at least, in depth. In shallow water, the orbits are no longer circles, but ovals, or approximate ellipses, of less height than length, according to the degree of shallowness.

When waves pass from deep into shallow water, as toward a beach, they become gradually shorter, their total energy is imparted to a less and less mass of liquid, and the extent of the motion of the particles is proportionately increased. The crests also travel faster than the troughs; so that the front of each wave becomes by degrees steeper than the back, and at length curls forward and falls over, exhibiting the well known roll of surf. The formulæ for waves in deep water require modification, therefore, to adapt them to waves in shallow water, where depth of liquid and ellipticity of orbit enter as elements.

It has been necessary, in order properly to explain the apparatus and its uses, to give more fully the leading points of the theory of waves, than would be required, were the works containing it more generally accessible. For these points the papers of Prof. Rankine have been chiefly consulted. It is hoped that this outline of the theory, thus incidentally given, will prove not unacceptable to such instructors as may not have at hand the original works; and that this new piece of apparatus may contribute somewhat toward imparting a clearer understanding of the phenomena of waves.

The apparatus has been patented, and is manufactured by Messrs. E. S. Ritchie & Son, the well known philosophical instrument makers, of Boston, Mass. L.

SCIENTIFIC INTELLIGENCE.

I. CHEMISTRY AND PHYSICS.

1. *On the effects of coloration presented by discharges from an inductorium taking place between a platinum wire and the upper surface of a liquid.*—E. BECQUEREL has communicated to the Academy of Sciences in Paris the details of an investigation some of the results of which appear to be of particular interest and value. The apparatus employed was very simple, and consisted merely of a glass tube partly filled with a saline solution in contact with a platinum wire forming one pole of an inductorium. The other pole consisted of a platinum wire the extremity of which was placed a few millimeters above the surface of the liquid, the discharge taking place between this last and the wire. When the inductorium is of low power no coloration is observed when the liquid is positive and the wire negative, but only when the wire is positive. But when the coil is powerful and the salt dissolved easily vaporized, coloration is observed in either case, though the maximum is given when the wire is positive. With a sufficiently powerful coil the luminous effects of the discharge are very bril-

liant. The spectrum of the light produced in this manner is more complex than that resulting from the introduction of small quantities of saline matter into a non-luminous flame. The water is vaporized and we have lines due to oxygen and hydrogen; the temperature is also higher than that of the flame of a Bunsen's burner. With very pure water the intensity of the discharge is feeble and the spectrum contains the red and blue hydrogen line corresponding to the dark rays C and F of the solar spectrum. With a strong solution of chlorhydric acid in water the tint of the discharge is slightly violet and the two red and blue rays are more distinct than with water. There are also an orange band and a few fainter rays throughout the extent of the spectrum. A very small quantity of a saline substance in water is sufficient to communicate to the light of the discharge the color due to the elements of the salt. Thus water containing one one-thousandth part of its weight of chlorid of strontium gives very distinctly the orange and blue rays characteristic of strontium. With concentrated solutions the effects are more marked and with the chlorids in particular they are very brilliant. Thus the chlorids of strontium, calcium, sodium, magnesium, copper and zinc give fine effects. But other substances such as various compounds of barium, potassium, antimony, iron, manganese, silver, uranium, &c., give effects which are more or less marked. In general the lines are more numerous than in the spectra of flames containing the same saline elements, which doubtless arises from the higher temperature, but in all cases the lines are the same as those given by Bunsen and Kirchhoff. Thus with a saturated solution of chlorid of strontium, besides the orange and the clear blue, we see two violet rays, one more intense than the other, several green rays one of which is particularly distinct, and a certain number of feebler rays in different parts of the spectrum. Chlorid of lithium, besides the red and the feeble orange, gives a very vivid blue ray. A concentrated solution of chlorid of calcium gives a great number of rays among which the dark blue ray is very intense. Chlorid of magnesium, besides other lines, gives two very bright green and one clear blue ray. Chlorid of zinc gives a red ray, three brilliant blue rays and a very intense violet line. Nitrate of silver gives among other rays, two of a vivid green. In conclusion the author points out the very obvious and marked advantages which this method of observation offers in certain cases over the usual method of ignition in a non-luminous flame.—*Comptes Rendus*, lxvi, 121.

W. G.

2. *On the permeability of cast iron to the gases produced in combustion.*—At the instance of Gen. Morin, Messrs. H. Sainte-Claire Deville and Troost have made precise analyses of the air which circulates round a stove of cast iron strongly heated. The authors have found that this air contains hydrogen and oxyd of carbon in notable quantities. This fact is perfectly explained by the permeability of iron at high temperatures to gases and by the property which iron possesses of condensing oxyd of carbon, dis-

covered by Graham. As the gases traverse the iron even at a dull red heat the authors call attention to the poisonous effect which the oxyd of carbon must produce and attribute to its presence the unpleasant sensations which are always experienced in rooms heated by cast iron stoves or by air heated by contact with hot iron plates.—*Comptes Rendus*, lxvi, 83. W. G.

3. *On stellar spectra.*—Secchi has communicated to the Academy of Sciences in Paris some further observations on stellar spectra, made by means of a new spectroscope with a cylindrical achromatic eye-piece. The author's conclusions are as follows: 1st. Red stars have generally spectra of the third type (like α Orion, α Hercules, β Pegasi, Antares, o Balænæ, &c.); when the color is pale it may be referred to an intermediate place between the second and third. 2d. A great number of these stars of the fifth or sixth magnitude have their spectra perfectly resolvable into columns which are afterward themselves resolvable into finer lines; such are the following:

Right ascensions.	Declinations.	Magnitudes.
$5^h\ 24^m\ \cdot1^s$	$+\ 18°\ 29'$	5·5
$4^h\ 46^m\ \cdot5^s$	$+\ 2°\ 16'$	5·5
$4^h\ 44^m\ 37^s$	$+\ 14°\ 1'$	5
$22^h\ 59^m\ 57^s$	$+\ 8°\ 39'$	5·5
$23^h\ 11^m\ 6^s$	$+\ 48°\ 15'$	

There are many others which cannot be resolved into secondary lines on account of the faintness, but of which the principal lines suffice to indicate the type. 3d. The stars which cannot be referred to the three established types are very rare. The author has examined several hundred stars below the seventh magnitude, one which is very extraordinary is found in Lalande's Catalogue, ($\alpha = 4^h\ 54^m\ 10^s$, $\delta = +\ 0°\ 59'$). In the spectrum of this star the red is divided into two bands by a broad obscure line, the yellow is reduced to a very clear and bright line, then comes a broad dark band, then a broad greenish-yellow band, then another dark space and then a blue zone. (The author gives a curve representing this spectrum. We may here remark that it is exactly analogous in general character to the spectra produced by colored liquids.—W. G.)—Sirius seen with the new spectroscope exhibits with great distinctness the beautiful dark band in the extreme red. Between this and the sodium line D there is a very delicate nebulous ray. The author hopes soon to furnish exact measurements of the rays, after finishing a general survey of the heavens with a view of detecting the most remarkable stars.—*Comptes Rendus*, lxvi, 124. W. G.

4. *On the reduction of niobium and tantalum.*—Marignac has made various attempts to obtain niobium and tantalum in the metallic state. These efforts though unsuccessful as regards their immediate object have resulted in the discovery of several new and interesting compounds. Fluoniobate of potassium is reduced without difficulty by sodium in a crucible of wrought iron, but the

product of the action is an alloy of sodium and niobium or niobid of sodium which presents itself under the form of a black powder. Water decomposes this body and transforms it into a niobid of hydrogen containing about 1 per cent of hydrogen and having the formula, NbH. The substance obtained by Rose was certainly a protoxyd of niobium, Nb_2O. The niobid of hydrogen is an extremely fine black powder of density 6—6·6. It is not attacked by chlorhydric, nitric or dilute sulphuric acid, but may be attacked and dissolved by concentrated boiling sulphuric acid and by fused alkaline bisulphates by boiling with caustic alkalies and particularly by fluohydric acid even when dilute. When heated in the air it ignites and is converted into niobic acid. The niobid of hydrogen is very stable and may be ignited for an hour in a current of hydrogen without change, except that its density increases to 7·37. Fluoniobate of potassium heated with magnesium produced a violent explosion. The reduction with aluminum in a crucible of graphite, yields a niobid of aluminum, $NbAl_3$, which is a highly crystalline iron grey powder, with a strong metallic luster and with a density of 4·45 to 4·52. Fluotantalate of potassium yields with aluminum an alloy of similar constitution and properties. The density of this body is 7·02; it dissolves easily in fluohydric acid.

H. Sainte-Claire Deville in presenting the above mentioned paper of Marignac described two new compounds of niobium obtained by himself but not analyzed. When niobate of potash is heated to about 1200 degrees with a small excess of carbonate of potash in a crucible of graphite surrounded by a mixture of rutile and carbon, very beautiful black cubes are obtained which are converted by chlorine into a mixture of chlorid and oxychlorid of niobium. When the calcination takes place in a crucible of graphite heated to the highest possible temperature, but not surrounded by rutile and carbon, prismatic crystals are obtained of a magnificent dark bronze color which are doubtless the nitro-carbid of niobium analogous to the well known titanium compound analyzed by Wöhler.—*Comptes Rendus*, lxvi, 180 and 183. W. G.

5. *Researches on Vanadium.*—The study of the compounds of vanadium by Berzelius led to the conclusion, since universally accepted by chemists, that vanadic acid like chromic acid has the formula, VO_3, and that the equivalent of the metal, using the term equivalent in its older and less logical sense, is 68·5. Roscoe has presented to the Royal Society an elaborate memoir, in which setting out from the well known isomorphism of vanadinite with apatite, pyromorphite and minetisite, he shows conclusively that vanadium belongs to the nitrogen group of elements and is triatomic and pentatomic. The grounds upon which these conclusions are based are in the author's words as follows:

1. An oxyd of vanadium exists having the atomic weight 67·2 (that of the metal of Berzelius). Hence vanadic acid contains more than three atoms of oxygen.

2. The following vanadium oxyds have been obtained both in the dry and wet way and their composition determined:—

(1.) VO vanadium monoxyd, or vanadyl, = 67·2
(2.) V_2O_3, vanadium sesquioxyd, (Berzelius suboxyd) " 150·4
(3.) VO_2, vanadium dioxyd, " 83·2
(4.) V_2O_5, vanadium pentoxyd (vanadic acid), " 182·4

3. The so called terchlorid of vanadium, VCl_3, (V=67·2), contains oxygen; it is an oxychlorid having the formula $VOCl_3$ (V=51·2); it may be called vanadyl trichlorid, or vanadium oxytrichlorid, and corresponds to $POCl_3$, phosphoroxyl trichlorid.

4. Three other solid oxychlorids exist, having the composition
1st. $VOCl_2$, vanadyl dichlorid, or vanadium oxydichlorid.
2d. VOCl, vanadyl monochlorid, or vanadium oxy-monochlorid.
3d. V_2O_2Cl, divanadyl monochlorid.
4th. All the native vanadates are tribasic.

5. Vanadium pentoxyd fused with sodium carbonate displaces three molecules of carbonic dioxyd, showing that normal or ortho-sodium vanadate is tribasic, the formula of this salt being Na_3VO_4.

6. The so-called mono-vanadates are salts corresponding to the mono-basic phosphates, and may be termed meta-vanadates, thus, $NaVO_3$, NH_4VO_3, Ba2VO_3. The so-called bivanadates are anhydro-salts, similar in constitution to the anhydro-salts of chromic and boric acids.

7. Vanadium nitrid has been prepared, which, on analysis, was shown to contain 51·2 parts by weight of vanadium to 14 parts of nitrogen.

The author determined the atomic weight of vanadium by the reduction of vanadic pentoxyd in hydrogen—the method originally employed by Berzelius. The mean of four determinations gave the number 51·37 with a mean error of ±0·066. Berzelius's number calculated in the same way for V_2O_5 is 52·55.

Monoxyd of vanadium, VO=67·2, is a gray powder having a metallic luster and is obtained by passing the vapor of vanadyl trichlorid, $VOCl_3$, mixed with excess of hydrogen through a combustion tube containing red-hot carbon. The oxyd in solution may be obtained by the action of nascent hydrogen upon a solution of vanadic in sulphuric acid. The solution has a lavender tint and is a very powerful reducing agent. It quickly absorbs oxygen from the air and becomes chocolate-brown.

Vanadic sesquioxyd, V_2O_3=150·4, (Berzelius suboxyd) is obtained as a black powder by reducing vanadic pentoxyd in hydrogen at a red heat. When exposed warm to the air it glows and passes to the highest oxyd. At the ordinary atmospheric temperature it slowly absorbs oxygen and gives the dioxyd. It is insoluble in acids but may be obtained in solution as a green liquid by the action of metallic magnesium upon a solution of vanadic in sulphuric acid.

Vanadic dioxyd, VO_2=83·2 (the vanadic oxyd of Berzelius) may be prepared in the form of blue shining crystals by allowing the sesquioxyd to absorb oxygen at ordinary temperatures. So-

lutions of this oxyd having a bright blue color may be obtained by the action of moderate reducing agents upon vanadic acid in solution.

Vanadyl trichlorid, $VOCl_3=173{\cdot}2$, was proved to contain oxygen by obtaining CO from the decomposition of the vapor by red hot charcoal; by the production of magnesia by the action of magnesium; by the formation of caustic soda by the action of sodium; by the formation of vanadic sesquioxyd by passing the vapor of the oxychlorid with pure hydrogen through a hot tube. Its density was found to be 1·841 at 14°·5 C., its vapor density 88·2 (H=1), and its boiling point 126·7 C. under a pressure of $767{\cdot}0^{mm}$. Nine analyses of this body gave 51·05 as the atomic weight of vanadium, the mean of which and the number already given 51·37 is 51·21 which the author adopts as the true atomic weight.

Vanadyl dichlorid, $VOCl_2=137{\cdot}9$, is a light green crystalline body obtained by the action of zinc on the trichlorid at 400° in sealed tubes. Its density is 2·88, it is insoluble in water but deliquesces on long exposure to air and dissolves easily in acids.

Vanadyl monochlorid, $VOCl=102{\cdot}57$, is a brown light powdery solid formed by the action of hydrogen upon vanadyl trichlorid at a red heat. It is insoluble in water but readily soluble in acids. Divanadyl monochlorid, $V_2O_2Cl=169{\cdot}8$, is also formed by the action of hydrogen at a red heat upon $VOCl_3$. It is a heavy shining metallic powder resembling mosaic gold in appearance. Vanadium mononitrid, VN, is a greyish powder unalterable in the air, obtained by heating the ammonium oxychlorid to whiteness in a current of ammonia. The dinitrid, VN_2, is the black powder obtained by Uhrlaub by heating the ammonium oxychlorid. The author promises to describe the compounds of vanadium with the halogens in another communication.—*Proceedings of the Royal Society*, xvi, 220. W. G.

6. *On the compounds of niobium and tantalum with chlorine and oxygen.*—H. Sainte-Claire Deville and L. Troost have communicated a few notes on niobium and tantalum which are of value as fully confirming the views of Marignac upon the atomic constitution of the compounds of these metals. Niobic acid was heated to redness in a platinum boat in a glass tube through which a current of dry carbonic acid was passed; chlorid of niobium $NbCl_5$ (fusing at 194° and boiling at 240°) was then repeatedly volatilized over the acid. The niobic acid disappeared almost completely to form a white silky body volatilizing at 400° which possessed all the properties of oxychlorid of niobium:

$$Nb_2O_5+3NbCl_5=5NbOCl_3.$$

No oxychlorid of tantalum could be obtained by the same process. Chlorid of tantalum—prepared from tantalic acid purified by Marignac's method—is a solid crystallizable body which melts at 211°·3 and boils at 241°·6 under a pressure of 753^{mm}. It has a pale yellow color and rapidly changes in the air, giving off scarcely visible vapors of chlorhydric acid and becoming covered with tan-

talic acid. Its vapor density at 360° was found to be 12·8 and at 440° 13·0; for a condensation to 4 vols. the formula $TaCl_5$ (Ta=182) should give 12·5. The density of tantalic acid precipitated from the chlorid by ammonia and ignited to low redness was 7·35.—*Comptes Rendus*, lxiv, 294. W. G.

II. MINERALOGY AND GEOLOGY.

1. *On the Age of the Gold-bearing Rocks, of California;* by Wm. H. Brewer.—In the last number of this Journal (this volume, p. 266), in a note on the Carboniferous Age of the gold-bearing rocks of California, by Prof. W. P. Blake, he complains of a single sentence in a previous article of mine (this Jour., July, 1866, p. 116), beginning with "and in the later pages of the same work he paves the way for priority of discovery," &c.

I beg here to say that I regret using the personal imputation in that sentence, and willingly retract it. It should not have been written, however great the provocation, and I especially regret using it as it had little or nothing to do with the argument of that article, and is now used to call attention away from the question there discussed to the alleged personal grievance.

That article by me was written in defense of the Geological Survey against certain imputations against it and certain of its members, put forth by him in a certain pamphlet containing claims for discoveries, and certain unwarranted statements. In his recent article he does not attempt to meet the facts I have published relating to the actual discoveries by the Survey, but speaking of the paragraph already referred to, says, "he controverts the written statements * * * by partially citing paragraphs from my Report," &c.

I certainly have no desire to misrepresent him nor his position. Inasmuch as he commits the same wrong he accuses me of, by but "partially citing paragraphs" from the same report, omitting some decidedly suggestive sentences, I would therefore respectfully suggest that any person curious in this matter should read the *whole* of those portions of his report which bear upon this question, and then form his own opinion as to what they really mean and what they are worth. (Geological Reconnoissance in California, preface iv, p. 276, 278 and 279.) It will be more suggestive if these be read entire and in connection with his later pamphlet and his recent article, where portions are cited, other portions omitted and the whole curiously explained.

In this recent article, Prof. Blake remarks that in my articles which he criticises, I made statements to the effect "that it was reserved for the Geological Survey to show that the gold-bearing rocks were not of these older periods. This is an error, inasmuch," &c. (p. 265). I did state that the State Geological Survey was the first "*to show*" this very thing, and I brought forward proofs of the correctness of the statement. I do not see the *error* he accuses me of, inasmuch as he does not meet a single item of these proofs, but instead offers some of his old surmises.

When I wrote those articles I was not ignorant that *surmises* had been recorded before, that "possibly" the rocks in question might be in part Carboniferous, but the articles in question dealt rather with what the Geological Survey had proved than with what others had guessed at.

I freely admit that surmises had been copiously put forth in Prof. Blake's report, and upon a variety of questions. He surmises that the Sierra limestones are "*possibly*" Carboniferous, (the Geological Survey has since *proved* the fact)—and also surmises that the gold rocks will in a great part "ultimately be found to be Devonian,"—that they may be "Silurian,"—that they were "probably impregnated with it [gold] after the Miocene period," —that the coast Ranges had been covered with the sea until "Post Tertiary times,"—and so on through a suggestive list of surmises, a few of which have been justified by later investigation, the most of which however are now known to be unfounded.

A paragraph in this recent article appears to indicate that he as much underrates the value of facts as he overrates the value of possibilities. Respecting the *age* of the very rocks in question, (the surmise of which age "was a bold step in advance,") he says (p. 266) "that as regards the portion of the gold-belt under consideration it is as yet a matter of opinion, not of demonstration." If he means by this that *he* never demonstrated it nor ever discovered one fact which could demonstrate it, or indeed throw any light at all upon it, then it is doubtless true; but if he means that it has not been demonstrated at all, as the language implies, then it is untrue. Apparently to illustrate that the last is his meaning, and to make it look probable, he adds, "The discovery of other localities of Carboniferous fossils in the northern part of the state, at Bass Rancho and Genesee Valley has afforded additional evidence, and yet Mr. Brewer very justly does not positively assert the Carboniferous age of this belt southward," &c. Here again Prof. Blake values facts too lightly as compared with the surmises which precede the quotation, and in but "partially citing paragraphs from *my* report," he curiously omits to mention that I had cited another locality of Carboniferous fossils many miles farther "southward" where the fossils are found in at least two beds or localities, separated by auriferous slates, and both enclosed in those slates. The locality is mentioned in the paragraph which he "partially cites."

It would be profitless to call attention to some other peculiarities of this recent article. I have published some of the more important facts and data relating to actual discoveries bearing upon the question. I did not exhaust the list, it could have been greatly extended, but it was considered sufficient for the purposes of the articles in which the statements appeared. It never occurred to me then that any one would attempt to throw discredit upon the facts themselves, without attempting to meet one of them, or to question the conclusions which they indicated, without bringing forward counter facts indicating other conclusions. Unless

facts and proofs are fairly brought forward to meet the statements I have recorded, I must decline further discussion upon this question.

But if scientific demonstration is to be placed upon the same footing as to value with mere suggestions and vague surmises, then I have nothing more to say. In that case, the sooner Geological investigation changes its mode of operations the better, and then let laborious exploration in the field give way to the richer results of a fertile imagination in the house.

New Haven, April, 1868.

2. *On Coal in Nebraska, with reference to a paragraph in the Geological Report of Dr. Hayden;* by C. A. WHITE, M.D. (Communicated for this Journal).—In the report of progress of the Geological Survey of Nebraska by Dr. F. V. Hayden, published in the valuable report of the Commissioner of the General Land Office for 1866, just issued, I see Dr. H. has, from some misunderstanding, alluded to a conversation between Mr. Meek and myself in his presence, at Nebraska City, respecting the probabilities of finding workable beds of coal there by deep mining. As the statement stands in his report, I am afraid that without further explanation some of the citizens of Western Iowa, who are interested in the subject of coal there, may be misled in regard to my real views upon that subject.

On page 125 of that report Dr. H., after mentioning the fact that Mr. Meek and myself had examined the country across from the Des Moines valley to Nebraska City, says that "the conclusion they arrived at was, that the workable beds of coal occur in the lower Coal-measures, and that those beds would be found by boring from 300 to 500 feet below the water level of the Missouri at Nebraska City."

In May, 1867, I invited Mr. Meek, as an old and highly valued scientific friend, to join my camp and cross the State of Iowa with me to Nebraska City, when on his way to Nebraska. I had, the year before, traced the Coal-measure rocks from the Des Moines to the Missouri river, and published the results, announcing the fact that nearly all the workable beds of coal in Iowa were to be found in the lower Coal-measures, and my object was to review the same in company with Mr. Meek. Upon our arrival in Nebraska we summed up the sections of the Coal-measure rocks we had made in Iowa, and found them to amount to between three and four hundred feet. In the conversation alluded to, which was held at the house of a mutual friend, we stated that *unless the upper unproductive member of the series should prove to be much thicker at and near Nebraska City than in Central Iowa* (no sections of the whole series were seen by us in Western Iowa), we thought it probable that the equivalents of the lower Coal-measures would be reached within 500 feet of the bottom of the Missouri valley. Neither of us, I am sure, had the slightest idea that what we stated to our friend would be understood by any one as a "*conclusion*" that beds of coal "*would be reached*" at any

designated depth. The problem is far too difficult a one to be disposed of in so summary a manner, especially as we had at that time scarcely more than commenced examinations in Nebraska. A few days after, we learned that borings had already been made at Omaha and Nebraska City to the depth of four hundred feet without finding a workable bed of coal. From these facts, and our examinations made immediately afterward along the Missouri river between Omaha and Nebraska City, we both arrived at the conclusion that the upper, unproductive series thickens more rapidly in extending westward from Central Iowa than is indicated by any evidence to be seen in traversing that State, and that it would be unsafe, in our present state of knowledge, to attempt to decide in regard to the actual depth at which the equivalents of the lower Coal-measure strata would be reached there, and that actual boring alone could decide whether *coal* existed there or not.

This conclusion was discussed by us in camp at the close of our examinations, in the presence of the whole party, Dr. H. included, and I supposed was understood by all.

My views in regard to the Coal-measures of Iowa, so far as they are yet formed, may be learned by consulting my articles in this Journal, and my reports. See First and Second Annual Reports of Progress, &c., of the State Geologist, Des Moines, March, 1868.

3. *Note on the shell-structure of certain Naiades;* by C. A. WHITE, M.D. (Communicated for this Journal.)—Those who have given attention to fossil lamellibranchiates cannot fail to have observed that whenever the shell-substance is preserved at all, it is universally thin, even in large specimens; too thin indeed to have given sufficient protection to the mollusc which it enclosed. It seems evident therefore that some portion of the shell-substance must have disappeared during the process of fossilization. Thus those fossil shells which possess a prismatic outer layer usually have this layer alone preserved, at least when they occur in calcareous strata. Numerous specimens of *Myalina subquadrata* from the Upper Coal-measures, and *Inoceramus problematicus* of the Cretaceous of Western Iowa illustrate this well, in which the interior markings are uniformly obliterated. While lately examining the Naiades of the Iowa river I observed that they all possessed a prismatic outer layer of a character not distinguishable from that of *Myalina subquadrata.* The prisms are of about the same size in each, but those of the Inoceramus are nearly twice as large.

The following species have thus far been found to possess the characters referred to: *Unio alatus* Say, *U. cornutus* Barnes, *U. crassus* Say, *U. ebenus* Lea, *U. plicatus* Say, *U. rectus* Lam., *U. securis* Lea, *U. tuberculatus*, *U. ventricosus* Barnes, *Alasmodonta complanata* Barnes, *A. truncata* Say, and an undetermined species of *Anodonta.*

This comprises all the genera (or sub-genera) found in our region, but it is not improbable that the prismatic structure is common to the whole family. The prismatic layer is of about the same thickness in all, the Anodontas and Alasmodontas being thinned at the

expense of the inner, or structureless layers. It is from half a millimeter to more than a millimeter in thickness, the epidermis resting directly upon it. Except in very old specimens, this layer constitutes the whole thickness of the shell for the width of a couple of millimeters from the margin, and in very young specimens it exclusively occupies about half the space between the margin and the pallial line.

The prismatic structure may be detected by the naked eye and can be well studied by the use of one of Tolles's ¾ inch triplet lenses. Under this magnifier the inner surface of the marginal border is seen to be finely granular, each granule being the convex end of one of the prisms which constitute the layer. These prisms extend through the layer to the epidermis without interruption, reminding one in their appearance upon fracture, of certain species of *Chætetes*. But viewing the prisms upon their ends they are seen to vary in size much more than the cells of *Chætetes* do, and consequently to lack that uniformity in cross section, presented by the coral.

If our Naiades were fossilized under the same circumstances that the Coal-measure and Cretaceous shells before mentioned have been, even the most massive Unios would doubtless be found with as thin a shell as *Myalina* and *Inoceramus* now possess.

Mr. F. B. Meek's investigations have shown that the prismatic structure is a very common, if not a constant character of the fossil Aviculidæ, and it is doubtless of much value as a family character; but since it is also seen in certain genera of Mytilidæ and the Naiades, it is known that it is not the peculiar property of any family.

4. *Note on "Cone in cone;"* by C. A. White, M.D. (Communicated for this Journal.)—The structure known as "cone in cone" or "tutenmergel" is quite common in the calcareo-carbonaceous shales of the Lower Coal-measures of Iowa. It usually occurs in somewhat concretionary layers, from four to twelve inches thick, the apices of the cones pointing downward. Being much interested in the views advanced by Prof. O. C. Marsh in relation to the origin of this structure, I was somewhat surprised to discover last summer in Southern Iowa, some facts which seem to be at variance with the opinion that the peculiar structure in question was produced by pressure upon the concretionary mass while it was forming. A couple of examples were found there which presented the cone-like structure radiating from a center, the apices of the cones all pointing to that center. The concretions were imbedded in the common dark shales of the Coal-measures, the largest one being about two and a half feet in transverse diameter, and one and a half feet in vertical thickness. It was broken open so that a vertical section was presented in its natural position in the face of the bank. The structure was plainly seen radiating as before described, being as distinct at the ends of the mass as in the upper and under

portions, and of the same character throughout. Thus in the same mass the apices of the cones were pointing in all directions.

Iowa City, Iowa, March 27th, 1868.

5. *First and second Annual Reports of progress by the State Geologist, and the Assistant and Chemist, of the Geological survey of the State of Iowa*, together with the substance of popular letters contributed to the newspapers of the State during the years 1866 and 1867, in accordance with law; also extracts originally contributed to scientific journals as a part of the work of the survey. pp. 288, 8vo. Des Moines, 1868.—This important volume consists largely of the articles communicated to the newspapers of the State as mentioned in the title. As such popular exhibitions of the results of the survey were required by the legislature, it was natural that they should be embodied in the annual reports intended for general circulation among the people. These articles and a brief report of the progress of the survey with which the volume opens, show that Prof. White is well fitted for the work in which he is engaged, and that the survey is bringing out results of great interest to science and the State. We are happy to announce that the Legislature has passed a bill appropriating $6,500 annually, for two years, for the prosecution of the survey. They have added a stipulation that the survey shall be finished in that time, which we hope may be modified, as it is quite too brief a period for completing the thorough examination of an area larger than all New England, Maine excluded. Mr. O. H. St. John will continue assistant for the coming year.

III. BOTANY AND ZOOLOGY.

1. *Shortia*, Torr. & Gray, *and Schizocodon*, Sieb. & Zucc., *identical.*—At the end of the separate herbarium of Michaux, in the museum of the *Jardin des Plantes*, Paris, is preserved a specimen, ticketed, "Hautes montagnes de Carolinie, an Pyrola spec.? an genus novum?" The scapes bear the dehiscent capsule, tipped with a style, and surrounded by the sepals; the corolla and stamens are absent. A sketch of the specimen, a leaf, and the summit of one of the scapes were obligingly presented to me by Prof. Decaisne. With more zeal than judgment, I drew up the characters from this unique and incomplete specimen, and in this Journal for January, 1842, in a note to the account of a botanical excursion to the mountains of North Carolina, I published the plant under the name of *Shortia galacifolia*, Torr. & Gray. Contrary to my hopes and expectations, the plant has not yet turned up in its native haunts. The late Dr. Short, who has since gone to his rest, deserved better commemoration at our hands than this empty name of a most obscure plant. Indeed, our botanists, applying the old law maxim, "*de non apparentibus et de non existentibus eadem est ratio*," are not unreasonably doubting if there ever was any such plant. Some lucky botanist will probably rediscover it in the region around the Black Mountains. What I have now to announce is, that the genus is found, and probably the very species, in a

widely distant region, indeed, but just where, after all we have been learning, it was not unnatural to expect it.

In the year 1843, if I mistake not (I cannot at this moment ascertain the exact date, none being given in the separate issue), the late Prof. Zuccarini published a plant from the mountains of Japan under the name of *Schizocodon soldanelloides;* and Dr. Maximowicz last year added two other species, *S. ilicifolius*, which he thinks too closely resembles the original species, and *S. uniflorus*. Of the latter, as well as of *S. soldanelloides*, Dr. Maximowicz has obligingly supplied me with specimens. *S. uniflorus* appears to differ (and perhaps too little) from the original species chiefly in the single-flowered scape, broader bracts, broader and more numerously-nerved sepals, and more slender style. Of this as of *Shortia, galacifolia*, the corolla and stamens are unknown. Until these parts are found, and prove to be different, I may venture to assume that the two are identical!

Dr. Maximowicz, the latest and best botanical explorer of Japan and the adjacent regions northward, and whose excellent specimens have been liberally supplied to some of the principal herbaria of of this country (where they are most interesting), is sedulously engaged upon a *Flora Japonica*.* It should be left for him to decide which generic name should be adopted, the earlier and incomplete or the later and complete one.

As to the affinities of the genus, I had thought mostly of *Galax*, itself of undetected relationship. The fringed, Soldanella-like corolla and the similar foliage are unaccompanied by any other structural resemblances. Zuccarini simply refers the genus to *Polemoniaceæ;* and I will add that its nearest known relative is *Diapensia*.

A. Gray.

2. *Prolusio Floræ Japonicæ, scripsit* F. A. Guil. Miquel.—We have recently noticed this interesting work as a part of the Annals of the Leyden Botanical Museum. It remains to add that, as a separate issue, it forms of itself a handsome folio volume, which is dedicated in complimentary and graceful terms to *Asa Gray* and to *C. I. Maximowicz*. It is indispensable to the study of Japanese Botany. We have just received also, from the same indefatigable author, a second essay,

Sur le Caractère et l' Origine de la Flore du Japon, an 8vo. pamphlet, and another upon the Japanese Maples. Neither time nor space will allow us at present to give an analysis of these works, and to enter upon the discussion of the most interesting problems brought before us by the comparison of the Japanese and North American floras, and of these with the Arctic tertiary flora recently illustrated by Heer, &c. In the preceding article we have added one more item to the curious chapter of facts, and we

* *Apropos* to this, I would state that the Imperial Botanical Garden of St. Petersburg, to which Dr. Maximowicz is attached, is very desirous to obtain, for its herbarium, specimens of North American plants, and especially those of our western and southern districts;—for which Dr. M. and Dr. Regel, the Director of the Garden, offer liberal returns in specimens of plants of the wide Russian empire, &c.

may return to the subject upon a future occasion. There are now very few peculiar Eastern North American types which are not directly represented (not rarely by identical species) in Japan or the adjacent regions, and the connection of all this with the former extension of North American types into Europe is now manifest enough. A. G.

3. *Genera Plantarum*; auct. G. BENTHAM et J. D. HOOKER. Vol. i, 1862–1867.—We have already announced the completion of the first volume of this important work. It may be useful now to take note of its pages merely as they affect North American Botany.

Ranunculaceæ. The ambiguous *Thalictrum anemonoides* is referred back to *Anemone*, where Linnæus placed it. Its aspect suggests that view, but its carpological characters do not. Both genera would be better defined if this troublesome little plant could be generically separated, as has been once or twice attempted. *Cyrtorrhyncha* of Nuttall, though quite peculiar, is most properly referred to *Ranunculus*. So is *Aphanostemma* of South America,—which interests us on account of a new Californian species, with white Anemone-like sepals and minute glandular petals.

Dilleniaceæ. To this order Nuttall's *Crossosoma* is appended, as it technically ranges here rather than with *Pæonia*.

Calycanthaceæ, following a view propounded long ago by Dr. Hooker, stand next to the following order: For "species 2" of *Calycanthus* we should read 3, if not 4, one Californian, and two if not three of the Atlantic States.

Magnoliaceæ. This order is made to include both the *Wintereæ* and the *Schizandreæ*, according to views with which we are here familiar. As in older works, the seeds of *Magnolia* are said to hang upon a filiform funiculus,—which is by no means the case. What funiculus there is to these nearly sessile seeds is thick; as they separate from the placenta, the copious spiral ducts in their center are stretched out and form the extensile thread. Our *Schizandra* has its character enlarged, to take in *Sphærostemma*, a Japanese species collected in our N. Pacific Expedition connecting the two.

Berberideæ, is made to include *Lardizabaleæ*, which does not concern North America. It is worth noting, however, that the abnormal production of two or more carpels in *Podophyllum* (which, it seems, is not very uncommon, although only lately noticed) goes to confirm this union. The flowers of *Caulophyllum* were better described by the word *luridi* than "*lutei*," and the discovery of the the pulpy arillus to the seeds of *Podophyllum*, attributed in the addenda to A. Gray, belongs to Dr. Torrey, and was first published in the Flora of the State of New York.

Papaveraceæ. The genus *Platystigma* takes in Nuttall's *Meconella*, adding two species, *P. Oreganum* and *P. Californicum*. *Stylophorum* gets enlargement, and too close approximation to *Chelidonium*, by taking in a Himalayan and also a Japanese species, each formerly regarded as of distinct genera. Although not in our way, there is an oversight in the character of *Pteridophyllum*, the stamens being alternate with, not "opposite" the petals.

Cruciferæ. Nuttall's *Phœnicaulis* is remanded to *Cheiranthus*. *Armoracia* is not referred to *Nasturtium* as we should think most proper, but is left in *Cochlearia*. *Arabis* includes *Turritis*, a view already adopted with us. *Cardamine* takes *Dentaria*, which is hardly necessary, while *Draba* is not allowed to swallow *Erophila*. *Warea* is said to have but one species, instead of two. *Pachypodium*, Nutt. is the name adopted (instead of *Thelypodium*, Endl.), but Lindley's genus of *Apocyneæ* pre-occupies that name. The Californian *Tropidocarpum* is said to have 6 species instead of 2, a typographical error. *Tetrapoma*, is not simply to be reduced (as suggested in addenda) to *Nasturtium palustre*, which, however, sometimes occurs in the tetracarpellary state. *Biscutella*, by including *Dithyrea* of Harvey, gets two American species, *B. Californica* and *B. Wislizeni*.

Caryophyllaceæ. The primary divisions are reduced to the rank of tribes, *Sileneæ*, *Alsineæ*, the latter including the stipulate *Spergula* and *Spergularia*, and *Polycarpeæ*, while the uniovulate *Illecebreæ* proper are to find a place next *Amarantaceæ*, and *Mollugo* and its allies go to the *Ficoideæ* further on,—the distinction between hypogynous and perigynous insertion being kept up as far as possible. As to genera, *Saponaria* and *Lychnis* are restored to their Linnæan limits, and so on. The position of the styles in respect to the sepals is corrected in the addenda as to *Sagina*, but not as to *Stellaria*. There is nothing more to remark as to the related orders, except that in,

Elatineæ, our anomalous Texan species is referred to *Bergia* on account of the pentamerous flowers and the habit, notwithstanding the dehiscence of the fruit. This seems proper, and so the plant must take the name of *Bergia Texana*.

Hypericaceæ. The typical genus is extended to include *Elodea*, a view which we are not inclined to adopt.

Malvaceæ. The order is arranged to include the *Bombaceæ*, but one of the authors has already shown that this is not a tenable arrangement, at least as respects *Cheirodendron* and our Californian *Fremontia*. Otherwise the arrangement proposed in this country is adopted; *Hibiscus*, however, embracing *Abelmoschus* and *Paritium*. Our curious *Thurberia* is suspected to be *Ingenhousia*, and thought to differ from *Gossypium* in its trimerous gynæcium; in the addenda the authors are reminded by Mr. Wright that common Cotton generally has a 3-celled ovary.

Tiliaceæ in their relations to *Flacourtiaceæ* and *Samydeæ* are considerably modified, but this does not concern our U. S. Botany.

Lineæ will require as to *Linum* some modification, on account of a group of tricarpellary, or even dicarpellary species now known in California.

Zygophylleæ. The genus *Tribulus* receives back *Kallstrœmia*. The Texan plant which is so ambiguous between *Guaiacum* and *Porliera*, is here inadvertently referred to both genera. It should, as we suppose, belong to the latter.

Geraniaceæ. The comprehensive, Jussiæan view of the order will

doubtless prevail; but we cannot quite be persuaded that *Tropæolum* is as near to *Pelargonium* as to *Limnanthes*. The cryptopetalous or bud-fertilized flowers of *Impatiens* are not noticed; those of *Oxalis* are, but not the dimorphism or trimorphism of the open petaliferous blossoms.

Rutaceæ, enlarged more than ordinarily, to include the *Aurantieæ*. It may be incidentally remarked that Mr. Mann's new Hawaian genus *Platydesma*, taken up in addenda, should have been placed next to *Medicosma*, to which it is most nearly related. Also, that it is through some misapprehension that the present writer is said in the addenda to have found 1 to 5 ovules in *Skimmia*; he never saw more than one.

Simarubeæ. Here our authors happily place *Suriana* and *Cneoridium*, Hook. f., a new genus founded on *Pitavia dumosa* of California, which Dr. Torrey had before indicated, but without completing the separation or detecting the true relationship.

Ilicineæ, placed between *Olacineæ* and *Celastrineæ*, are yet thought to be most allied to *Ebenaceæ* among the *Corollifloræ*. *Prinos* is joined to *Ilex*, according to the view long since adopted and carried out with us.

Celastrineæ. *Celastrus* is said to have a few North American species: we know only one.

Ampelideæ. *Vitis* is made to include not only *Cissus* but *Ampelopsis*, which, in a comprehensive view, cannot well be objected to.

Leguminosæ comprise 399 genera, brought up to a few over 400 in the addenda, under 3 suborders and 23 tribes. Reverting to his earliest view, Bentham's *Microlotus* section of *Hosackia* is remanded to *Lotus*. The species may, in a general view, be inseparable from *Lotus*, but they are quite as much so from *Hosackia*, and here geographical considerations may as well govern the case. *Lathyrus* is properly made to include *Orobus*, and of course Nuttall's *Astrophia* also, which had been already referred to it by Endlicher. Both *Amphicarpæa* and *Apios* prove to be genera of some extent, having Himalayan species. *Galactia* takes in *Collæa*, which comes into our southwestern borders. *Cæsalpinia* takes in not only various things which had been separated, but also *Guilandina*.

Rosaceæ. Here the primary groups which have ranked at least as suborders are reduced to tribes, and these extended to ten, the *Chrysobalaneæ* being one. *Amygdalus*, &c., being merged in *Prunus*, this tribe is called *Pruneæ*,—a needless change, as even the order *Onagrariæ* is allowed to retain that name, although *Onagra* has been merged in *Œnothera* ever since the days of Linnæus. On account of the evident albumen in the seed and the habit, *Spiræa opulifolia* is transferred to *Neillia*, an eastern Asiatic genus,—a change which we hesitate to adopt. To *Gillenia* is attributed imbricated petals, whereas they are convolute, but so we find those of *Spiræa Aruncus* to be. *Potentilla* is taken in so enlarged a sense as to include not only *Sibbaldia*, which seems inevitable, but also *Horkelia* and *Ivesia*. *Sanguisorba* is absorbed in *Poterium*, and Nuttall's *Peraphyllum* is regarded as a digynous *Amelanchier*.

Saxifrageæ. Here, again, the so-called suborders are reduced to tribes, and the family is made very comprehensive, including even the *Ribesieæ* (which name there is hardly good reason for adopting in place of *Grossularieæ*), and is placed immediately after *Rosaceæ*. By writing the original name *Saxifrageæ*, the authors fall into the needless difficulty of having precisely the same name both for the order and the tribe. We do not make out the ground of their obvious dislike to the termination *aceæ*, which is manifestly called for in the present instance. In the synopsis, *Rodgersia* has lost its *d*, and *Boykinia* is credited with double its actual number of stamens. The sixth section, *Isomeria*, of *Saxifraga*, is superfluous, and belongs mainly to *Boykinia*. In the second line of the character of *Astilbe*, a "*vel*" should be supplied after "liber." *Lithophragma* is, not unnaturally, referred back to *Tellima*, but is perhaps better as a distinct genus. A very interesting new genus from California, *Bolandra*, Gray, recently published, will find a place near *Tolmiea*, *Tiarella*, and *Tellima*. *Parnassia* is incorporated into this tribe, next to *Lepuropetalon*, and the position of the stigmas relative to the placentæ is corrected in the addenda.

Crassulaceæ. Here we have only to remark that *Echeveria* is reduced to *Cotyledon*.

Droseraceæ, on account of a slight adnation in some species, are brought into the neighborhood of *Saxifragaceæ;* but in *Dionæa*, where this is perhaps most pronounced, while the calyx-tube is said to be "*basi ovarii adnatus*," the petals and stamens are described as hypogynous,—statements which are not quite congruous.

Halorageæ, adopted as an order and placed at some distance from *Onagrarieæ*, contain *Callitriche*, probably because one knows no other more fitting place for it. The great orders *Myrtaceæ* and *Melastomaceæ* require no mention in the present connection.

Lythrarieæ. Didiplis, Raf., 1833, is adopted for *Hypobrichia*, M. A. Curtis, but the single species may as well be referred to *Ammannia*.

Onagrarieæ. In the seeds of some species of *Jussiæa*, an investment derived from the pericarp is confounded with the testa; and Rothrock's very distinct genus *Heterogaura* is adopted.

Passifloreæ. The tendrils of *Passiflora* are inadvertently said to be lateral, instead of axillary. Our authors refer *Papayaceæ* directly to this order.

Cucurbitaceæ. The genus *Trianosperma* of Martius gets its name from *Bryonia*, section *Trianosperma* (not "*Trianospermum*") in Torrey and Gray's Flora. The original, *T. Boykinii*, is abundantly different from *Bryonia*, but is not altogether congruous with the West Indian *Cionandra* of Grisebach. If there be really "fifteen species" of *Echinocystis*, and most of them pentamerous in the calyx and corolla, then the "interdum 6-meri," noted at the close of the character, may suffice. But apparently the original species is always hexamerous. *S. Oreganus* is certainly *Megarrhiza*, which we are not disposed to follow Naudin in regarding as *Echinocystis*,

and we fancy that all the species with several parietal and ascending ovules, which are referred to in the generic character, are nearer to *Elaterium* than to genuine *Echinocystis*. This third tribe, also, may need reconstruction. *Cyclanthera* is in our view monocarpellary, and its ovules horizontal. The second section of *Sicyos*, *Sicyocarya*, is misprinted *Sicyocarpa*.

Datisceæ. We were prepared for the reduction of *Tricerastes*, Presl., to the typical genus, where it becomes *Datisca glomerata*.

The *Cacteæ* are here arranged according to views intermediate between those of Salm-Dyck and those of Engelmann.

Under the old Jussiæan name of *Ficoideæ* (which it were better to be rid of) our authors have assembled *Mesembryanthemum* and its near relatives, such quasi-Portulaceous plants as *Sesuvium*, *Trianthema*, &c., the *Molluginеæ*, and some genera which have of late been referred rather to *Phytolaccaceæ*, the connecting links, indeed, of several Caryophyllineous and Portulacaceous groups.

The *Umbelliferæ*, which were in a most unsatisfactory state, have been wholly re-arranged, and reduced to a much more practicable form; but it does not seem possible to make the genera altogether satisfactory. Without sketching the new arrangement, we will merely refer to the North American genera which are affected by it. The vittæ, whether single or more numerous in the intervals, being much relied on, our *Tauschia Texana* is referred to *Eulophus*. But *Eulophus* itself is likely to be merged in *Araccacia*. *Deweya*, so merged in this work, proves however to have some good characters, which have recently been pointed out in another place (Proceed. Amer. Acad. June, 1867), and, strengthened by two additional species, is likely to stand. *Apium* is made to include both *Helosciadium* and *Leptocaulis*, the species of which are yet to be re-examined and re-settled; but we have elsewhere assigned reasons why it cannot take in our species of *Sium* proper, as Bentham and Hooker propose. *Carum* is immensely enlarged, and to it is referred *Zizia aurea*, with wingless fruit (the relations of which to *Thaspium* still require investigation), and *Edosmia*, Nutt., a sort of *Bunium*, of which there is now a second Californian species. *Pimpinella* gets a representative in the Atlantic States in *P. integerrima* (*Zizia integerrima*), and in the paper above referred to we have added a Californian one, *P. apiodora*. The Texan *Daucosma* is referred to *Discopleura* (*D. lacimiata.*) Nuttall's *Glycosma* (now also represented by two species) is merged in *Myrrhis*. *Phellopterus*, probably anticipated by the name *Glehnia*, as we have previously remarked, is founded on our *Cymopterus? littoralis* of the western North American and the northeastern Asiatic shores. *Ligusticum* comprises *Cynapium*, Nutt., and the plants referred to *Conioselinum* are unsatisfactorily divided between this genus and *Selinum*. *Peucedanum* is the name adopted for the most comprehensive group of the single-winged species, including *Pastinaca*, *Tiedemannia*, *Archemora* and *Euryptera*. Nuttall's *Leptotænia* is kept up; but we have elsewhere proposed to reduce it to *Ferula*. Nuttall's *Atrema* justly becomes *Bifora Americana*. *Ammoselinum*, Torr. and

Gray, is given in the addenda; but we take it to be a long-fruited *Apium*.

Under *Cornaceæ* we have only to note that *Benthamia* is reduced to a section of *Cornus* little different from that to which *C. florida* belongs: also that *Garrya* finds its resting place here.

A. G.

4. *Traité Général de Botanique descriptive et analytique.* 1me *Partie, Abrégé d' Organographie, d'Anatomie, et de Physiologie.* 2me *Partie, Iconographie, Description et Histoire des Familles.* Par Mm. LeMaout and J. Decaisne. *Ouvrage contenant* 5,500 *figures dessinies par* Mm. L. Steinheil *et* A. Riocreux. Paris. Firmin Didot et Frères, Fils et Cie. 1868. pp. 745, small folio.—A copy of this work, from one of the authors, has reached us barely in time for this brief notice of it in the present place. It is a most handsome and beautifully printed volume, a compendium of all botany (phænogamous and cryptogamous), as the title shows, illustrated by a profusion of attractive wood cuts from original drawings, a part of which, however, have already done service in its precursor, LeMaout's *Atlas Elémentaire.* To all teachers a complete treasure, both for the text and the illustrations, is here richly provided for their lectures and lessons,—illustrations which may be depended on for accuracy. Such a large and fresh stock of figures is an invaluable acquisition to the teacher's resources; and the text we presume to be equally reliable. It is published in Paris at a very moderate price for such a volume, in itself a library. A. G.

5. *Gray's Manual of the Botany of the Northern United States. Fifth Edition, Second Issue,* 1868.—A prefatory note states that, "in the present issue many small corrections, typographical and other, have been made throughout the volume, as well as more considerable alterations on pages 479, 480, 564; an omission of the proper acknowledgment for the article on Sparganium is supplied on p. 481; and additional species, with a few more extended emendations, are given on pages 679–682." The sheet containing the addenda will be supplied by mail to any who have the first issue, in 1867, upon application, enclosing a two-penny stamp, either to the publishers or to the author. A. G.

6. *Illustrations of the Genus Carex, by* Francis Boott, M.D. Part IV, Tab. 412–600. 1867.—We extract the following from J. D. Hooker's Preface. "The publication of this part is wholly due to the munificence of Mrs. Boott, who issues it as a tribute to the memory of her late husband,—an earnest of his abiding zeal in this elucidation of his favorite genus, and of his love of science and desire to promote it. In the same liberal spirit Mrs. Boott (in 1865) presented the whole of Dr. Boott's botanical collections, manuscripts and drawings, to the Royal Gardens of Kew, then under the directorship of her husband's earliest surviving friend, the late Sir W. J. Hooker." . . . .

What a noble tribute is this volume to the memory of her husband; others may rear the stately monument or storied urn to near

and dear friends, but here is a monument more enduring than marble, and more eloquent than studied phrase or glowing verse.

The tables are numbered 412 to 600, illustrating each plant in full size, and drawn with great beauty and spirit, with ample dissections of the parts, following the "Explicatio Tabularium" as laid down in Part I. These 189 plates illustrate 124 species. Forty five of them are found in North America, viz:—

Carex Halleriana, *Asso.*
pedunculata, *Muhl.*
aperta, *Boott.*
bicolor, *All.*
circinata, *Meyer.*
Buxbaumii, *Wahl.*
Gmelini, *Hook.*
fulva, *Good.*
pallescens, *L.*
Pseudo-Cyperus, *L.*
and var. comosa.
stylosa, *Meyer.*
Breweri, *Boott.*
leiocarpa, *Meyer.*
mirata, *Dew.* in Wood, not in Sill. Jour.
gynocrates, *Wormsk.*
tenuiflora, *Wahl.*
teretiuscula, *Good.*
var. major (Ehrhartiana).
var. ramosa (prasina, *Dew.*).
polytrichoides, *Muhl.*
panicea, *L.*
nigricans, *Meyer.*
Pyrenaica, *Wahl.*
vaginata, *Tausch.*
heleonastes, *Ehrh.*
glareosa, *Wahl.*
var. C. ursina, *Dew.*
canescens, *L.*
Carex arcta, *Boott.*
maritima, *Vahl.*
ampullacea, *Good.*
compacta, *R. Br.*
physocarpa, *Presl.*
rupestris, *All.* and var.
scabrata, *Schw.*
Sitchensis, *Prescott.*
viridula, *Michx.*
salina, *Wahl.* (ambusta, *Boott*, Ill. 172).
var. minor (lanceata, *Dew.*)
var. Hoppneri, *Boott.*
obesa, *All.*, var.
vesicaria, *L.*
lævigata, *Smith.*
aquatilis, *Wahl.*
var. minor.
acuta, *L.*, var.
vulgaris, *Fries.*
var. alpina (C. rigida, *Good*).
var. hyperborea (C. Bigelovii), *Schw.* and *Torr.*
angustata, *Boott.*
var. (C. stricta, *Dew.*)
var. (C. strictior, *Dew.*)
microglochin, *Wahl.*
Jamesii, *Torr.*
laciniata, *Boott.*

Of these, *Carex Breweri*, belonging to the Phyllostachys group, and *Carex laciniata*, of the Acutæ group, are here first described. This last plant was figured as *C. Wilkesii*, Torr. ined. U. S. Ex. Expedit. The descriptions are numbered from 292 to 524. (*C. Hartwegii* and *C. Mexicana* are both referred by the learned author in Herb. Hook. to *C. polystachya*, β, Boott, or *C. cladostachya*, Wall.) Twelve species are simply numbered, without descriptions, and among these, to the regret of American Botanists, are *C. ampullacea*, *C. vesicaria* and *C. viridula*, Michx.

Eighty-four drawings, 601–684 in the Herbarium at Kew, are referred to as illustrating descriptions 417–484, sixty-nine species; of which eighteen are North American, viz:—

Carex cæspitosa, *L.* var. filifolia.
capillaris, *L.*
capitata, *L.*
elongata, *L.*
fœtida, *Allioni.*
globosa, *Boott.*
juncea *Willd.*
lagopina, *Wahl.*
leiorhyncha, *Meyer.*
leporina, *L.*
Carex micropoda, *Meyer.*
muricata, *L.*
β gracilis. (C. Hookeriana.)
nigella, *Boott.*
obtusata, *Liljeblad.*
pauciflora, *Lightfoot.*
podocarpa, *R. Br.*
remota, *L.*
stenophylla, *Wahl.*

The descriptions 486–524, 39 species, have neither plates nor drawings to illustrate them. Thirteen of these are North American, viz:—

Carex chordorhiza, *Ehrh.*
extensa, *Good.*
holostoma, *Drej.*
incurva, *Lightfoot.*
Mertensii, *Prescott.*
nardina, *Fries.* (C. Hepburnii, *Boott*).
Norvegica, *Wahl.*
Carex paludosa, *Good.*
pedata, *Wahl.*
petricosa, *Dew.*
præcox, *Jacq.*
triquetra, *Boott.*
vitilis, *Fries.*
α. (C. Persoonii).
β. sphærostachya.

Under *C. triquetra* reference is made to plate 417. That number figures *C. alligata*, a very different species. *C. triquetra*, a Californian plant, resembles *C. Halleriana*, Tab. 415–416, and no figure of it is given.

Thus, of the North American species, 45 are illustrated by plates, 18 by drawings in the Kew herbarium, and 13 have descriptions only, making 76 species in all.

A small tribute of affection and gratitude American Botanists might well pay to the memory of Dr. Boott by publishing the illustrations now deposited in the herbarium at Kew. We propose to give a complete enumeration of the North American species described in the four parts of this work, with notices of those omitted, in some subsequent number. S. T. O.

7. *The Variation of Animals and Plants under Domestication;* by CHARLES DARWIN, M.A., F.R.S., etc. 2 vols., with illustrations. 8vo. London, Murray, 1868.—At the present moment we can only announce that an American reprint of this important work is just issued by Orange Judd & Co., New York, the publishers of the American Agriculturist, at less than half the cost here of the English copies. To this edition some words of preface, corrections, and additions have been contributed by the author himself.

8. *Critical remarks on the Halcyonoid Polyps in the Museum of Yale College, with Descriptions of new Genera;* by A. E. VERRILL. *Muricea.*—This genus has been very judiciously restricted by Dr. Kölliker* to species like *M. muricata* (*spicifera* Lamx.), having the cells covered with imbricated, fusiform spicula.

* Icones Histiologicæ, ii, p. 135, 1866.

For *M. placomus* and similar forms he has established the genus *Paramuricea*, and for *M. cerea* Dana, and allied species, the well characterized genus *Echinogorgia*. In Prof. Dana's Zoöphytes the first two species of *Muricea* alone belong to the restricted genus, but his *Gorgonia tuberculata* Esper should be added. The first four species in Milne Edwards's Coralliaires are true *Muriceæ*. Dr. Kölliker admits seven species. In the Museum of Yale College there are now twenty one species of true *Muricea*. Of these, three came from the Indo-Pacific fauna, three from the Carribean, and fifteen from the Panamic. Of the latter, nine species are new and are now being published by the writer.* To this number must be added *M. horrida* Mobius, of Peru; three West Indian species; *M. pendula* Verrill, of S. Carolina; *M. tuberculata* Köll., *M. vatricosa* K., and *M. humosa* K., to complete the whole number of species now known.

Gonigoria clavata Gray, Proc. Zool. Soc. 1851, p. 124, is doubtless also a young *Muricea*.

Muricea muricata Verrill = Gorgonia muricata Pallas; Ellis and Sol., = Muricea spicifera Lamx. Exp. Meth., Tab. 71, f. 1 & 2, 1821.

There appears to be no sufficient reason for rejecting the original name of this common West Indian species.

M. elegans Duch. and Mich., Corall. des Antilles, p. 19, 1860, = M. elongata Dana (non Lamoroux).

If the original *M. elongata* be correctly described and figured, it cannot be this species, but rather an *Acis*. *M. elegans* Verrill, Bulletin M. C. Z., p. 36, 1864, is a different species, since changed to *M. pendula* V., in Mem. Boston Soc. Nat. Hist., i, p. 45, July, 1864.

M. laxa Verrill, Bulletin M. C. Z., 1864, is a distinct Florida species.

M. robusta Verrill, loc. cit., p. 36; and Proc. Bost. Soc. Nat. Hist., 1866, p. 329.

The supposed white variety, formerly included under this species, proves to be the following distinct species, common at Panama.

M. albida. This is characterized by its somewhat appressed cells with an elongated and flattened lower lip; its thick branches; and long, acute, fusiform, very thorny spicula.

M. hebes Verrill, op. cit.

The supposed purple variety, formerly included with this species, likewise proves to be a distinct and common Panama species, where the typical form is also common.

M. purpurea, is characterized not only by its deep purple color, known in no other species, but by its short appressed cells, thick, often clavate branches, and short, blunt spicula. It also grows much larger than *M. hebes*, and branches dichotomously.

Muricea appressa Verrill, Bulletin M. C. Z., Jan. 1864, = Eunicea Tabogensis Duch. and Mich., Supl. Corall. Antilles, p. 171, Tab. iii, f. 5, 6, 1864.

* Transactions of the Connecticut Academy of Arts and Sciences, vol. i, part 2. New Haven.

Although the exact date of the latter work is unknown, it could not have been until after May, since, on page 7, there is a foot-note dated "Turin, 17 Mai."

Muricea flexuosa Verrill, = *Lissogorgia flexuosa* V., Proc. Essex Inst., iv, p. 187, 1865.

This species appears to be referable to *Muricea*, but, with other East Indian species, forms a distinct section of the genus, characterized by a very thin cœnenchyma, composed chiefly of large fusiform spicula, from among which the small cells rise at right angles to the surface, thus approaching *Acis*, but differing from the latter in having the cells covered by fusiform spicula.

Muricea nitida Verrill.

This elegant species is allied to the last; but differs in the bright purplish-red color, and larger size of the spicula, which compose, almost exclusively, the cœnenchyma. These are relatively very large, long fusiform, blunt at the ends, often crooked, the surface finely papillose and shining. Those of the polyps are bright yellow. The cells are small, verruciform, and covered by small fusiform spicula, branches slender, axis light yellowish brown, horn-like.

Ebon Island, Central Pacific, on *Stylaster elegans* Verrill,—(H. Mann).

Anthogorgia divaricata Verrill, = Muricea divaricata V., Proc. Essex Inst., iv, p. 188, 1865, pl. 5, fig. 5 and 6.

The genus *Anthogorgia* is now proposed for this remarkable form. It is characterized by very prominent, tubular cells, eight-rayed at summit; a thin cœnenchyma containing imbedded fusiform spicula; those of the cells long, fusiform, thorny, imbedded at various angles in the surface, but not imbricated.

Paramuricea cancellata Verrill, = Gorgonia cancellata Dana, 1846, = Villogorgia nigresens Duch. and M., 1860, = Lissogorgia flabellum Verrill, 1864 (non Antipathes flabellum Pallas; ? A. flabellum Esper. Tab. i.), = Paramuricea nigrescens Köll., 1866, = Echinogorgia flabellum Verrill, this Jour. 1866, vol. xlii, p. 283.

This is unquestionably Dana's species, and identical with *Paramuricea nigrescens* Köll., who has sent me spicula from an authentic specimen. Esper's name was erroneous, having been pre-occupied in both *Gorgonia* and *Antipathes*. Therefore, if his *A. flabellum* proves to be this species, Dana's name should still have preference. The reference by Prof. Dana to Esper's *G. pseudo-antipathes* proves to be wrong, for Dr. Kölliker has found that the latter is a *Gorgonella*, but he has, by a similar error, referred Dana's species to this as a synonym. The genus *Lissogorgia*, founded on *P. cancellata*, must be dropped, unless the latter should prove to be generically distinct from *P. placomus*, the type of *Paramuricea*, from which it differs widely in appearance, though agreeing pretty well in the form of the spicula. The characters given to *Villogorgia* Duch. and Mich., are entirely erroneous, and the name has a false signification.

Genus *Heteorogorgia* Verrill.—This genus has been established upon two curious species from Panama. It is characterized by a

horny axis; smooth cœnenchyma, with very small, spindle-shaped spicula; verruciform cells, armed at the summit with longer, slender, projecting and divergent, sharp spicula, which are often much bent.

H. verrucosa V., is a low species, with few clavate branches and prominent verrucose cells.

H. tortuosa V., has smaller, crooked, irregular branches; smaller, less prominent, and scattered cells; and grows to the height of six inches or more.

Psammogorgia arbuscula Verrill, = Echinogorgia arbuscula Verrill, Proc. Bost. Soc. N. Hist., 1866, p. 326.—The genus *Psammogorgia*, proposed for this species, is characterized by a rather thick cœnenchyma, with the surface granulated by the numerous very small, rough spicula. These are of several forms, but mostly short, thick, blunt spindles, very strongly papillose, and thorny; others are irregular, as broad as long, very thorny; some are pretty regular stars with five, six, or more, rough rays. The cells are either somewhat prominent or flat, and scattered on all sides.

Astrogorgia Sinensis Verrill, = Muricea Sinensis V., Proc. Essex Inst., 1865, p. 187, Pl. 5, f. 5, 5a.—This genus is allied to the last, and like it has a granulated surface, and the cells scattered on all sides, and usually verruciform. The spicula of the cœnenchyma are, however, very different, being nearly all long, fusiform, sharp, warty "spindles" of various sizes. In alcoholic specimens the tentacles are not wholly retracted, but form a low cone, covered by the conspicuous spicula at the bases of the tentacles.

Juncella extans Verrill, Bulletin M. C. Z., Jan., 1864, p. 37, = J. flagellum Johnston, Ann. and Mag. Nat. Hist. 14, p. 142, Aug. 1864.

Plexaura suffruticosa Edw. and Haime, = Gorgonia suffruticosa Dana.—An examination of the spicula of this species proves it to be a true *Plexaura*.

Plexaura spicifera Verrill, = Gorgonia spicifera Dana.—Common at Aspinwall, (F. H. Bradley, Col. Totten).

Plexaura crassa Verrill, Bulletin M. C. Z., 1864, = Gorgonia crassa Ellis and Sol. (non Dana).—This species is not the *Plexaurella crassa* Kölliker, which appears to be the *P. turgida* Verrill, l. c. (? Ehr. sp.), but whether the latter be really Ehrenberg's species cannot be ascertained without an examination of the original specimens.

Plexaura reticulata (? Ehr.) Philippi, Wieg. Arch., p. 119, 1866. Mr. F. H. Bradley collected several specimens of this species at Callao. In microscopic structure it is a *Gorgonia* Köll., but the name, *G. reticulata*, has already been used, and is inappropriate for this species, hence the following name is proposed for it:

Gorgonia (*Litigorgia*) *Peruviana* Verrill, is characterized by its very ramulous, low, shrubby growth, the branchlets short, crooked, often slightly coalescent, the terminal ones subpinnate. Cœnenchyma rather thick, cells small, flat, scattered. Color whitish; height 4 to 6 inches.

Genus *Gorgonia*.—Dr. Kölliker has reunited all the Gorgonaceæ with horny axis to *Gorgonia*, in which he forms three sections, characterized by the spicula:—

1st. *Species having only spindles.* This includes a few species of *Pterogorgia* Ehr., *Rhipidogorgia* Val., *Leptogorgia* Edw., *Lophogorgia* Edw., etc.

2d. *Species having spindles and crescent-shaped or bracket-shaped spicula* ("*Klammern*"). This corresponds nearly with *Pterogorgia* Ehr., and includes *Xiphigorgia*, *Pterogorgia* and *Hymenogorgia* of Edwards, and *Rhipidogorgia flabellum* Val.

3d. *Species having a peculiar external layer of club-shaped spicula.* This includes the typical species of *Gorgonia*, as restricted by Edwards.

Among the 17 species which are in the Museum of Yale College from the west coast of America, not a single one can be referred to the second or third sections of the genus. The species of the second section are very numerous from the West Indies and Atlantic coasts of America. Those of the third section are mostly Mediterranean and African, so far as known. The Panamic species divide naturally into two groups, containing about equal numbers.

1st. Species having only warty "double-spindles" in the cœnenchyma, which are of two sorts, longer and shorter.

2d. Species having "double-spindles" and "double-wheels."

In each of these groups the modes of branching are various, and there are species with either flat or raised cells. These groups, like the 2d and 3d of Kölliker's, seem sufficiently marked and distinct to merit recognition either as genera or, at least, as sub-genera, and therefore I have proposed the following names:

Litigorgia for the first group, including *G. media* Verrill, and *G. Agassizii* V., with reticulated branches; *G. lævis* V., with virgate; *G. Floræ* V., with bipinnate; *G. ramulus* Val., *G. diffusa* Verrill, *G. pumila* V., and other species with pinnate ones.

Eugorgia for the 2d group. These species all have a distinctly granulose surface, owing to the large number of small naked spicula, the cells are mostly in two lateral bands. It includes *G. ampla* Verrill, *G. nobilis* V., *G. rigida* V., *G. flexilis* V., *G. cuspidata* V., and *G. Bradleyi* V., with long branches, often virgate or flabelliform; *G. stenobrachis* Val., with reticulated branchlets; *G. Daniana* V., and *G. Mexicana* V., with bipinnate ones, and prominent cells.

G. (*Litigorgia*) *Adamsi* Verrill, = Rhipidogorgia ventalina Duch. and Mich., Supl., (after May) 1864, p. 90, Tab. iii, f. 3. (non Gorgonia ventalina Pallas).

G. (*Litigorgia*) *lævis* Verrill, Proc. B. S. N. H., p. 327, 1866, = Lophogorgia alba Duch. and Mich., op. cit., p. 19, Tab. iv, fig. 2, 1864 (non Gorgonia alba Lam.).

G. (*Eugorgia*) *Mexicana* Verrill, = Lophogorgia aurantiaca Horn, Proc. Phil Acad. Nat. Sci., 1860, p. 233; Gorgonia aurantiaca Verrill, Bull. M. C. Z., p. 33, (non Gorgonia aurantiaca Edw., Corall., 1857).

A fine, large specimen of this beautiful species, from La Paz, Gulf of California, is in the collection.

Xiphigorgia citrina Verrill, Bulletin M. C. Z., 1864, = Gorgonia citrina Esper, = X. Americana D. and M., Supl., 1864, = Gorgonia citrina Köll.; ? Pterogorgia citrina D. and M., Supl.

Erythropodium Pacificum Verrill, = Sympodium Pacificum, Verrill, Proc. Bost. Soc. N. H., 1866, p. 329.

Telesto trichostemma Verrill, = Gorgonia trichostemma Dana, Zoöph. p. 665, Pl. 59, f. 3, 3a, 3b.—An examination of the original specimen of this species shows that it is a parasitic polyp (probably a *Telesto*) allied to *Cornularia*, covering in the lower part the dead axis of an *Antipathes*, but in the upper part rising up into slender, hollow branches of its own.

Cyathopodium tenue Verrill, = Allopora tenuis Dana, Zoöph., p. 630, Pl. 59, fig. 5, 1846.—This new genus is proposed for the remarkable little polyp, rightly described by Prof. Dana as closely allied to *Tubipora*. It is in fact a Tubipora-like polyp, with short, cup-shaped tubes, connected by narrow calcareous stolons, which correspond to the tranverse plates of *Tubipora*, and from which the new buds arise.

9. *Notice of the Corals and Echinoderms collected by Prof. C. F. Hartt, at the Abrolhos Reefs, Province of Bahia, Brazil*, (with one plate); by A. E. Verrill. (From the Transactions of the Connecticut Academy of Arts and Science, vol. i. New Haven, Feb. 1868).—In this paper 19 species of corals and 16 of Echinoderms are enumerated as collected on the Brazilian coast by Mr. Hartt. The Echinoderms are mostly West Indian species, yet three are described as new (*Echinaster crassispina*, *Asterias Atlantica*, and *Thyone Braziliensis*), and notes on the localities and stations of most of the species are given by Mr. Hartt. The occurrence of *Oreaster gigas* Lutk., so far south, is noteworthy. Of corals, nearly all the species are peculiar to Brazil. The following are described as new:* *Siderastræa stellata*, *Favia leptophylla*, *F. gravida*, *F. conferta*, *Acanthastræa Braziliensis*, *Heliastræa aperta*, *Mussa Harttii*, *Symphyllia Harttii*, *Porites solida*, *Pterogorgia gracilis*, *Millepora nitida*, *M. Braziliensis*, *M. alcicornis*, var. *cellulosa*.

Mr. Hartt furnishes this account of the Brazilian coral-reefs and the distribution of the species:

"The following general conclusions may be added with reference to the coral-fauna of Brazil.

"1st. The species are, as Prof. Verrill above remarks, almost without exception, peculiar to the Brazilian coast, along which they have quite a wide distribution; the most of the species ranging from Cape St. Roque to Cape Frio, which seems to be the southern limit of the fauna. In the Bay of Rio de Janeiro, where the conditions appear to be very favorable for coral growth, I have been able to

* Brief descriptions of several of these new species appeared also in the March No. of the American Naturalist, Salem, Mass, accompanying an account by Mr. Hartt of his trip to the Brazilian coast, which is also continued in the April No., with an interesting description of the coral reefs.

find only one or two species of madreporarian corals, and these were *Astrangiæ*.

"2d. The Brazilian fauna bears a close resemblance to the West Indian, and there are many representative species. Thus the *Siderastræa stellata*, *Heliastræa aperta*, *Favia gravida* and *Porites solida*, are representatives of West Indian forms; and among the Halcyonoids, *Hymenogorgia* represents the *Rhipidogorgiæ* of the West Indian fauna.

"3d. The absence, in the Brazilian fauna, of the genera *Madrepora*, *Mœandrina*, *Diploria*, *Manicina*, *Cladocora*, *Oculina*, genera so characteristic of the West Indian fauna, is noteworthy.

"4th. The Brazilian corals form extensive reefs, which occur along the coast, from the "Roccas," north of Cape St. Roque, to the Abrolhos. The genera which contribute most to the reefs are *Acanthastræa*, *Favia*, *Heliastræa*, *Siderastræa*, *Porites*, and *Millepora*, but the *Mussa* and other species add a more or less notable share.

"South of the Abrolhos region, there are no known coral reefs. Very extensive ones occur in the Abrolhos region, at Itacolumi, Porto Seguro, Sta. Cruz, and in the vicinity of Camamú, and elsewhere south of Bahia. In the Bay of Bahia are large coral banks, and off the town of Maceiò, in the province of Alagóas, there are large irregular coral patches, uncovered at low tide, which are seen extending northward along the coast toward Pernambuco. Coral patches occur frequently on the coast farther north, and the extensive reef of the Roccas, in the latitude of the island of Fernando de Noronha, is formed of coral.

"Around the Abrolhos Islands are *fringing* reefs. Between these Islands and the shore is a large area of shallow sea, full of irregular reefs. On the Brazilian shore, in open water, the corals grow in small patches on the sea-bottom, and rise vertically to the surface like towers. These structures are termed, in Brazil, *chapeirões* (sing. *chapeirão*). In some instances they are only a few yards in diameter, while their height may be 40–50 feet or more. These *chapeirões* usually grow close together, and sometimes coalesce to form reefs of several square miles in area. The larger reefs are usually surrounded by chapeirões. Ordinarily, the reefs reach a level a little above low-tide. They are remarkably level topped. Occasionally sand is heaped upon them, and they become islands, but instances of this kind are very rare."

10. *Notice of a Collection of Echinoderms from La Paz, Lower California, with a Description of a new Genus of Starfishes;* by A. E. Verrill. From Transactions of the Conn. Academy of Arts and Sciences, vol. i, April, 1868.—This list furnishes additional information concerning the fauna of the Gulf of California. Several rare species are enumerated and *Tripneustes depressus* A. Ag. is, for the first time, described, and also a new genus and species of starfish, *Amblyaster insignis* Verrill.

The genus *Amblyaster* is allied to *Oreaster*, and still more so to *Nidorellia* Gray. It is depressed, five-rayed, covered on both sides, with large, polygonal plates, nearly all of those of the back bearing

large, conical spines, which form three rows on the rays. The marginal plates alternately approach and recede from the margin, and are alternately smooth and spine-bearing.

11. *On the Families of the Raniform Anura.* From the Journal of the Philadelphia Academy of Arts and Sciences; by E. D. Cope. (Received Feb. 1868, without date.)—The arrangement and structural characters of the genera of Raniformia, which are here divided into six families, are well presented in this memoir. Several new genera and species are described, and there are many useful criticisms and important changes in synonymy. The paper is supplemented by remarks upon some structural features of Arcifera, with a revision of the genera allied to Hyla, and descriptions of some new species. v.

12. *On the Spongiæ Ciliatæ as Infusoria Flagellata; or, Observations on the Structure, Animality, and Relationship of Leucosolenia botryoides Bowerbank.* By H. James Clark. Memoirs Boston Society of Natural History. Vol. I, Part III, 4to, with two lithographic plates. Boston, September, 1867.—In this memoir Prof. Clark has described in much detail and beautifully illustrated the internal and external structure of many species of the lower flagellate infusoria, belonging to the genera, *Monas*, *Bicosœca* (gen. nov.), *Codonœca* (gen. nov.), *Codosiga* (gen. nov.), *Salpingœca* (gen. nov.), *Anthophysa*, *Astasia*, *Anisonema*, *Dysteria* and *Pleuronema*. All these are shown to be more or less closely related to the siliceous sponge, *Leucosolenia botryoides*, the structure of which is fully illustrated and described. This sponge is composed of immense numbers of monad-like infusoria arranged side by side in a layer that lines all the cavities. These sponge-monads have, like all the other genera named above, except *Monas*, a sort of membranous collar surrounding the anterior end, and are furnished each with a long slender lash or flagellum corresponding to that of the other genera, and also have two distinct pulsating vesicles, and all other parts much as in *Codosiga* and *Salpingœca*, to both of which it is closely allied. The sponge, in fact, appears to bear a relation to the species of *Salpingœca* and other simple, monad-like infusoria, similar to that which the compound corals bear to the simple *Actiniæ*.

These investigations not only prove the animality of sponges, but show that, at least, those allied to *Leucosolenia* must be referred to the ciliated division of the *Protozoa* instead of Rhizopods, where they have been hitherto placed by Carter and others. v.

13. *Remarks on the Geology of the valley of Mackenzie River, with figures and descriptions of Fossils from that region in the Smithsonian Institution, chiefly collected by the late Robert Kennicott, Esq.;* by F. B. Meek. 53 pages, large 8vo, with 6 lithographic plates. From the Transactions of the Chicago Academy of Sciences, vol. I. Chicago, 1868.—In the introductory account of the Geology of the Mackenzie River, Mr. Meek shows that most of the rock exposures examined along that river, between Clear Water river and the Arctic Ocean, are of Devonian age, and correspond with

the Hamilton formation and Genesee slate of the United States. The slates in some places give rise to brine springs and petroleum. A considerable number of Corals and Brachiopods, and one Cephalopod (Gyroceras Logani) are described as new, and beautifully illustrated. Many others are given as identical, or probably identical, with species already described from the United States and Canada. The new species, also, are mostly allied to Hamilton fossils of the United States. It is thought probable that a continuous band of Devonian rocks, mostly Hamilton, extends in a northwesterly direction from Rock Island, Ill., to the Arctic Ocean, a distance of 2,500 geographical miles in a right line. Some species of fossils from localities near the extreme ends of this belt, or separated by nearly 30° of latitude, are pronounced undoubtedly identical, showing that in paleozoic times marine temperatures were but little influenced by latitude. The excellent typography and plates of this memoir are very creditable to the Chicago Academy and the officers under whose superintendence the first volume of Transactions is now being published. v.

14. *The Fossil Cephalopods of the Museum of Comparative Zoology;* by Alpheus Hyatt. Bulletin of the Museum of Comparative Zoology, No. 5. 32 pages, 8vo. Cambridge, without date (received Feb., 1868).—This contains lists of the numerous species of Ammonites contained in the Museum of Comparative Zoology from the Lower, Middle, and Upper Lias. The Ammonoids are treated as a distinct order of Cephalopods, and those included in these catalogues are divided into ten families, which are subdivided into numerous new genera. Several new species are also described, and critical synonymy of other species is given. Doubtless many paleontologists will hesitate before adopting all these subdivisions of the great "genus" Ammonites, but the work is evidently the result of a long and careful study of one of the largest series of these fossils to be found in any museum, and may therefore be regarded as approaching as nearly to a true classification as the state of preservation of the specimens will admit. v.

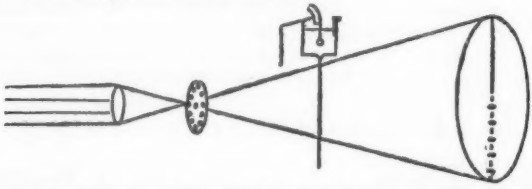
IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *On convenient forms of Experiment with fluid jets;* by Prof. Francis H. Smith (from a communication to J. D. Dana, dated University of Virginia, Feb. 29, 1868).—The following descriptions of some serviceable forms of experiment with fluid jets may be of interest to a few of your readers.

To obtain the water-jet, presently referred to, a small glass funnel was cemented to an opening in the bottom of a bucket. A valve was constructed by wrapping a 3 oz. leaden bullet with buckskin, and suspending it over the funnel from one end of a lever mounted upon the edge of the bucket. Placing the latter upon a tall tripod, and filling it with water, the operator has control of a satisfactory jet, which he can start and stop at pleasure. This rude apparatus leaves, perhaps, nothing further to be desired in the way of vertically falling jets.

Exp. 1. *Resolution of the jet.*—A large cylindrical beam of sunlight was introduced horizontally into the darkened chamber. The beam was condensed to a focus, with a double-convex lens. Between this focus and a screen, the jet of water was made to fall; a well defined shadow of the jet was thus thrown upon the screen, and it was easy to see a marked difference in the intensity of the shadow of the tranquil and troubled sections. Just at the focus referred to, was placed a circular disc of card-board, rotated by clock-work, and perforated all round, near its margin, with a number of equi-distant holes. When this was properly adjusted and set into rotation, the jet and screen were illuminated by a rapid succession of flashes of light.* Instantly the troubled section of the jet and its shadow was seen to be resolved into vibrating drops. When the flashes followed each other as fast as the drops, the shadows of the latter were stationary on the screen. If the velocity of the disc were now slightly reduced, the shadows slowly descended, and were seen to palpitate from prolateness to oblateness in a surprisingly distinct manner. If the disc be urged to greater speed, the shadows of the drops appear to ascend, according to a well known optical relation. It may be added, that by changing the relative distances of the jet and screen from the illuminating focus, we may make the shadows of the drops so large as to be seen without difficulty from the remotest parts of the largest lecture-room. I need not say that the electric lamp would furnish, in respect of steadiness, a better means of illumination than the sun.

This experiment was first tried by me in October 1867, with a jet of quicksilver, strongly illuminated. The image of the jet was formed on the screen, and suitably interrupted at short intervals of time. The result was satisfactory, but was liable to the objections that the image was inverted.



Exp. 2.—The jet was chastened into greater regularity of structure by the sound of a monochord, tuned to tension with it, or more

* When the disc is spinning very rapidly, the illumination of the screen seems to be continuous, but a white wand or string, or a fiddle-bow, shaken in the light, will demonstrate to the spectators its interrupted character. When the hand, with its fingers extended, is moved rapidly to and fro in the light, a monstrous appearance is presented, which must be seen to be appreciated. The appearance also of a stretched cord vibrated transversely in the intermittent cone of light, is instructive. Its *apparent* wavings, the velocity of the perforated disc being kept uniform, change of course with the tension of the cord. When the vibrating cord appears stationary, its time of vibration is a multiple or sub-multiple of the interval of the flashes of light. As it is not difficult to decide this "indetermination," we have here, it appears, a method of determining the number of transverse vibrations, per second, of a tense cord.

simply by receiving its troubled section upon a resonant surface, so placed that its tremors were transmitted to the reservoir through the legs of the tripod. The phenomena before described were now more marked, the intermittent light enabling us to trace in detail the influence of the sound, in abridging the tranquil section of the jet, and causing incipient swellings and strictures high up upon the latter. The reflection of sonorous beats also may be more narrowly observed by this form of experiment.

Exp. 3.—The jet was received in its smooth section upon a polished circular metallic plate, considerably wider than the jet, and one of Savart's liquid sheets, ten inches in diameter, was formed. When the unisonant monochord was sounded, the sheet was at once abolished. It was interesting to watch the resolution of the curved sheet of water, in the interrupted light, both with and without the aid of the neighboring sound.

Experiments with like results were made with oblique and vertically ascending jets. In all cases the intermittent light invested the results with new interest and instruction. If I am not mistaken, the method here described is far preferable in simplicity, certainty and ease of control, to that of electric flashes from the Leyden Jar, whether used for research, or mere lecture-room illustration.

In reference to gaseous jets, allusion will at present be made only to sonorous flames in tubes.

2. *Resolution of the Sounding flame;* by Prof. F. H. Smith, (ib.)—By those who have no mirrors, lenses or revolving apparatus, and who find a difficulty in properly moving the eyes to and fro before the flame, the intermittent character of the latter, when sounding, may be exhibited by simply shaking a chalk crayon near it, and noting the marked change assumed in the appearance when the flame passes from silence to song.

With a revolving apparatus, however, the following form of experiment will be found satisfactory. To the margin of a blackened disc of card-board, was cemented a silvered glass bead. This was set into rapid rotation in a dark room, and in close proximity to the flame in the glass tube. While the flame was silent, there was presented to the eye fixed upon the revolving bead, a complete luminous circle, which, when the flame began its song, was broken up into detached beads of light. By increasing the velocity of the disc, these brilliant points, or lumps, were reduced in number, and stretched into separated luminous arcs. The tube used was three feet long, and it was found possible to secure such a speed as to have only five luminous arcs. If the revolving mechanism be furnished with a counter or register, like the syren, we have here a simple and ready method of determining the number of vibrations per second of a sounding flame. For this purpose the bead should be light, and the disc small. For lecture-room illustration, the silvered ball should be large, so as to give a larger image of the flame, and a more voluminous bright circle.

To illustrate the use of the method suggested above, let me cite

the following measurements. Employing a glass tube, $3\frac{1}{8}$ feet long, with an average diameter of nearly $1\frac{1}{16}$ inches, and keeping the bead whirling so as to present five stationary luminous arcs, the first and second observations gave, each, 1576·8 rotations of the disc in 43 seconds. The third and last gave 2014·8 rotations in 56 seconds. Giving to each observation the same weight, we have 182·2 vibrations of the sonorous flame per second.

The syren, applied to the same problem, gave 177·7 vibrations per second, but it must be added, that I found it impracticable to keep my syren exactly in unison with the flame, at so low a note. Beats were heard during almost the entire period (90 seconds) of the experiment.

The note in question, compared with those of a set of excellent tuning forks made by Ritchie of Boston, was nearly F.

Again, the luminous arcs were, as nearly as I could judge, about 48° each in extent. This being so, the light of the sounding flame endured *conspicuously* at each pulsation, $0^{s}\cdot00366$ or $\frac{1}{273}$ of a second.

It was noticed too that each arc varied in brightness, the point of maximum illumination being, not at the center of the arc, but beyond it; so that it would appear that in each luminous interval, the flame lost its light more rapidly than it acquired it.

I have spoken of the luminous arcs as though they were absolutely detached from each other. So they appear to a careless observer. A close scrutiny, however, revealed an extremely faint and fading thread of bluish light uniting them. Hence, in this case at least, we cannot accept Dr. Tyndall's conjecture that there is an *absolute* extinction periodically, of the singing flame.

3. *Supplement to Prof. Smith's paper;* by the author.—I have applied the revolving silvered ball to the solution of the following problems. (1.) *To adjust two sounding flames to exact unison*, or to test the perfection of accord between two apparently unisonant flames.

The revolving ball presented to the two flames, gives two intersecting circles of images, which, in case of exact unison, are equal in number, and present identically the same retrogradations, stations and advances during the variable motion of the ball.

(2.) *To determine the exact, or the approximate, value of the musical interval between two sounding flames.* Adjusting the velocity of the ball, so that each flame gives a circle of *stationary* images (luminous arcs), the relative number of these images will express the interval required. Thus for one pair of flames, I found the interval to be 2 : 1; for another pair 4 : 3.

If, when one set of images is stationary, the other set has a slow motion, the relative number of the images will give an approximate value of the interval, the direction of the motion with respect to that of the ball determining whether the value is too large or too small.

For these applications it is obviously unnecessary for the rotating mechanism to be furnished with a register. Indeed a kaleidophone might be used for the same purposes, though with some inconven-

ience. The silvered balls I have employed, vary from ½ inch to 2 inches in diameter.

It is scarcely necessary to apprize the readers of this Journal, that the method herein set forth is a simple modification of an experiment devised and described by Prof. W. B. Rogers.*

In the progress of these experiments, it was often noticed that the luminous arcs, or stretched images of the sonorous flame, were placed in echelon. The reason is manifest, when the silvered ball is revolved slowly and close to the flame. The separate images are then found to be inclined in the direction of revolution, their inclination augmenting with the velocity of the convex mirror, and the slope of the after edge of the image being steeper than that of the front edge. The same tilting of the images occurs, as is well known, in resolving the flame either by Wheatstone's or Tyndall's processes, when the mirror, plane or concave, is rapidly turned. I am not aware that the significance of this fact has attracted attention. Does it not indicate that the flame both recovers and *loses* its light progressively from base to summit, the loss being more rapid than the recovery; and that at no single instant of its history, is the sounding flame such in *size* and *form*, as it appears to be when steadily viewed? Moreover, if the flame, in any case, be rekindled from above, as it must be, if it is ever absolutely extinguished while sounding, it would seem that its image on its first edge at least should be tilted *in a direction opposite to the motion of the mirror*.

I shall conclude these notices by stating a fact bearing upon the theory of these flames. I have found no difficulty in causing the flame to sing when inserted quietly into a horizontal tube, *carefully leveled*. Tubes of various lengths and diameters were used. In narrow horizontal tubes, the vibrations are soon arrested by the accumulating products of combustion. In a tube 1¾ inches in diam. and 3 feet long, the flame sang for an indefinite time. While it was sounding, no drifting of smoke previously introduced into the tube, or of a column of smoke rising past its distant end, could be detected. It is easy to pass from the ordinary *erect* position of the tube and gas jet, through all grades of inclination, to *the inverted position of both, without cessation of the sound*, and without disturbing the *axial* position of the flame.

If by maladroit handling, the flame is silenced at the critical attitude, it will be observed that the latter is below the horizontal position.

4. *On a convenient form of Aspirator;* by Prof. Albert R. Leeds, of Haverford College, Pa.—A pail containing water is placed at the edge of the table, and to the stop-cock which is attached to the side of the pail near the bottom, a tube of two or three feet in length is connected to carry off the water to a bucket placed on the floor below. When the bucket is filled, the stop-cock is turned off for a moment, and the water poured back into the pail. To the top of the stop-cock tube, which should be made

* This Journal, vol. xxvi, p. 10.

straight and somewhat longer than usual, and in front of the stop-cock itself, a short vertical tube is attached and connected by means of india rubber tubing with the wash-bottle or other vessel through which gas is to be drawn. On partially opening the stop-cock, the deficiency of water is made up by a large quantity of air or gas, which is drawn in through the vertical tube above mentioned.

Writing on a Screen.—Every lecturer has felt how unsatisfactory it is to write or draw or in any manner attempt to illustrate his ideas in a large room. This difficulty may be overcome in the following manner: A plate of glass is placed in the limelight or magnesium lantern, and an inverting prism put in the forward part of the draw-tube of the objective. If now, while looking and lecturing to the audience, writing is done with an ordinary pen and india-ink upon the glass plate and proceeding from left to right upon the plate, it will advance correspondingly upon the screen and will be read in greatly enlarged characters by those present. The square prism inverts with respect to bottom, and the writing being actually reversed by the writer in reference to the other direction in which the lantern is pointing, the crossing of the rays produced by the lens becomes in this case an advantage and corrects the letters upon the screen. A collodion film blackened by exposure to the sun's rays, may be substituted for a naked glass plate to great advantage. On such a film, chemical and mathematical formulæ, drawing of apparatus, machinery, crystals, anatomical delineations, etc., may be cut with the utmost delicacy, and appear as intensely bright white lines on a black ground, and with something of the appearance of an immense copper-plate engraving.

5. *Height of Mt. Washington.*—The height of Mt. Washington, attributed on p. 378 of last volume by this Journal to Prof. Bond, was obtained by Prof. Guyot.

OBITUARY.

Dr. SAMUEL LUTHER DANA died at Lowell, Mass., March 11th, 1868. His death resulted from a fracture of the thigh bone caused by falling on the ice some weeks before.

Dr. Dana was born at Amherst, N. H. in 1795. He fitted for college at Phillips Academy, Exeter, and entered Harvard University at the age of fourteen. Immediately after graduation he went into the army, and served as lieutenant of artillery till the close of the war of 1812. Completing his medical course of studies in 1818, he practiced as a physician for a few years. But having a special fondness for chemistry he relinquished his medical practice to engage in the manufacture of chemicals and continued to superintend the works of the Newton Chemical Company for many years. In 1833 he accepted a situation as chemist of Merrimac Print Works in Lowell, a position which he held up to the time of his death. He devoted himself with great skill, zeal, and industry to matters connected with calico printing, and contributed much to the success of the Company, by whom he was employed. Being of a progressive disposition he conceived some peculiar ideas

respecting the bleaching of cotton, which were communicated to the Société Industrielle de Mulhouse, and published in their Bulletin in 1836. His plan, which is now very generally used, is commonly known as the "American method" of bleaching.

By his investigations into the action of cow-dung in clearing mordanted calico of the thickening, he was naturally led to inquire into the nature of manures in general, of mold and the substances then little known but afterward more fully examined by Mulder and others and distinguished as gein, harmin, and ulmin. The collateral knowledge thus acquired was freely communicated to others and awakened so great an interest that he was at length induced to issue a treatise on the chemistry of soils and manures, under the quaint title of "A Muck Manual for Farmers." He also wrote an essay on Manures, for which he received a prize from the Massachusetts Society for Promoting Agriculture. In point of time, originality, and ability, Dr. Dana stood first among scientific writers on agriculture in this country.

But the agricultural treatises by which he became so well and favorably known, were but the secondary results of his research into the nature of cow-dung. The original object was worked out with full success. He found that the property of fixing mordants is due, in a great measure, to the presence of phosphates, and that the bulky animal excrement might be effectually replaced by cheaper and more convenient phosphate of soda prepared from bones. But Dr. Dana being the employee of a manufacturing company, was not allowed to secure a patent or to make the discovery known to the world. It was, however, of too much value and importance to remain long a secret; and when another person went to England with a full knowledge of the experiments at the Merrimac Print Works, and sought to derive a pecuniary benefit from the discovery, it was found that Mercer had been making similar trials with arseniate of soda. In fact the English and the American chemist independently originated the use of the dung substitutes, but to Mercer belongs priority of time by a few months.

In 1840 Dr. Dana made a report to the City Government of Lowell, on the various well-waters of the city, with special reference to their action on lead pipes. And for the sake of making more generally known the character of slow poisoning by lead, a matter then little understood by physicians themselves, he superintended the translation and publication of Tanquerel on Lead Diseases, the work of translation being done chiefly by his daughters.

In 1851 the manufacture of rosin oil was brought to his notice and he contributed much to the improvement of that then important branch of industry.

In later years his time was taken up by the duties of his position and the cultivation of a farm which he had purchased for the purpose of testing his peculiar views. Dr. Dana was of a retiring nature and was seldom away from the scene of his daily labors. Those who sought him out would not fail to be most favorably impressed by his geniality, his readiness to communicate knowledge, and his evident integrity of character.

V. MISCELLANEOUS BIBLIOGRAPHY.

1. *Elementary Introduction to Practical Mechanics.* Illustrated by numerous examples: being the third edition of "Elementary Examples in Practical Mechanics," by JOHN F. TWISDEN, M.A., Professor of Mathematics in Staff College. London, Longmans, Green, & Co. 1868. pp. 320.—Nothing so thoroughly fixes mathematical principles in the mind, as the working of examples. This conviction seems to have been acted upon by the author of the work before us. Indeed, his book, in its first editions, was professedly a collection of examples intended to supplement other treatises. But, in this third edition, it has been enlarged by the addition of such statements and demonstrations of principles, as make it now an independent work. It differs from other elementary treatises, both in the more practical turn given to the whole subject, and, especially, in the very large number of examples—over 800 in all. The examples appear to have been judiciously selected and to be particularly adapted to the wants of students in Engineering, whether Civil, Mechanical or Mining. The work seems to us an excellent one to follow any first book of Theoretical mechanics, such as *Peck's Elements.* We very much wish that a reprint of it, or some American work on a like plan, were published as a text book, for use especially in our schools of science.

2. *Berghaus's Chart of the World* (4th edition), published by Justus Perthes, Gotha. B. Westermann & Co., New York. Price $10.—This beautiful chart exhibits in the neatest and most perspicuous manner a greater amount of physical and commercial information than can be found in any other atlas. The exquisite finish of the maps issued by Justus Perthes is too well known to require commendation; nothing in this line of art elsewhere prepared is equal to them. This World-chart is drawn on the Mercator Projection, the longitude starting from Greenwich. It shows the tracks of those lines of sailing packets, steamboats and telegraphs, which now form the connecting links between the continents and islands of the globe; the streams and currents of the oceans and of the drifting ice; the shallow-water and deep-sea-soundings; the distances between the principal ports and the mean-time occupied in the trips of 57 various lines of steamers and sailing packets; and also the continental railroads and telegraphs, particularly those that communicate direct with steamer-lines. Additional maps, on a larger scale, of the Isthmus of Suez, of Panama, of Nicaragua and of Tehuantepec, a map of the plani-globes on Polar Projection, a wind-chart and a map showing the lines of equal magnetic declinations fill the corners and other vacant spots of the chart.

A separate edition is issued in the language of each of the great commercial nations, and it has been adopted by the Bureau of Charts for the U. S. Navy.

3. *Organic Philosophy.* Vol. II. *Outlines of Ontology, Eternal Forces, Laws and Principles;* by HUGH DOHERTY, M.D. 455 pp. London, 1867. (Trübner & Co.)—The publication of the first volume of this work was noticed in vol. xxxviii, 1864. The author divides his work into two parts; 1st, investigation of principles, and 2nd, discussion of principles. Under the first part occur the following heads of sections: Unity of science; Methodological sciences, Astronomical sciences; Ontological sciences; Transcendental philosophy; Perfective philosophy; Evolutive philosophy (in which and elsewhere he opposes strongly the hypothesis of Darwin); Constitutive philosophy; and part second includes the three sections: Evolutive facts and theories, Philosophies, Theosophies and Theologies. The work is condensed in the statements of its views, and in parts somewhat abstruse, but is one that may be read with much profit.

4. *Notes on the Volcanoes of the Hawaiian Islands, with a history of their various eruptions;* by WM. T. BRIGHAM, A.M. 465 pp. quarto, with plates and wood-cuts. From the Memoirs of the Boston Society of Natural History. 1868.—A very valuable memoir on the volcanoes, ancient and modern, of the Hawaiian Islands, after personal examinations by the author.

5. *Transactions of the Chicago Academy of Sciences*, vol. i, part 1.—I.—J. H. MCCHESNEY; Descriptions of Fossils from the Palæozoic Rocks of the Western States, with illustrations—page 1. II.—I. A. LAPHAM; Climate of the country bordering upon the great North American Lakes,—page 58. III.—F. B. MEEK; Remarks on the Geology of the Valley of the Mackenzie River, with figures and descriptions of Fossils from that region, in the Museum of the Smithsonian Institution, chiefly collected by the late ROBERT KENNICOTT,—page 61. IV.—C. A. WHITE and O. H. ST. JOHN; Descriptions of new Subcarboniferous and Coal-measure Fossils, collected upon the Geological Survey of Iowa, together with a notice of new generic characters observed in two species of Brachiopods,—page 115. V.—WM. STIMPSON; Illustrations of North American Birds in the Museum of the Chicago Academy of Sciences,—page 128.

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